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NEW YORK SEATTLE

MOTORSHIP

Devoted to Commercial and Naval Motor Craft

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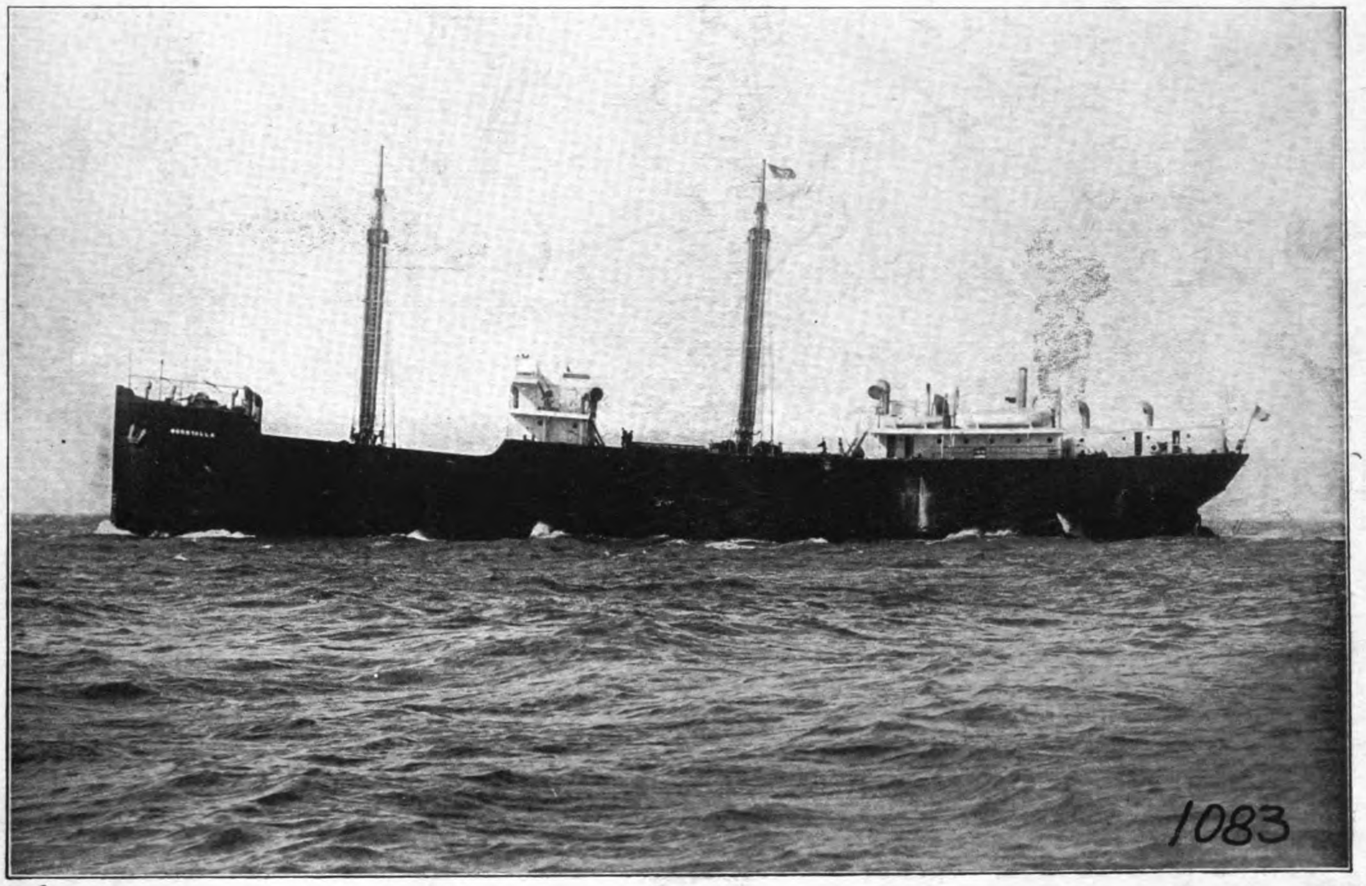

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MOTORSHIP

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Published Monthly in the Interests of Commercial and Naval Motor Vessels and for Recording International Progress of the Marine Internal-Combustion-Engine

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EDITORIAL

THE MOST MODERN, MOST EFFICIENT AND MOST ECONOMICAL MACHINERY!

It is possible that there are people who will endeavor to question the definition of the terms *"the most modern, the most efficient and the most economical type of machinery"* as outlined in the last issue of Motorship, which phrases are stipulated in the Jones-Greene Merchant-Shipping Act. But, we are glad to note several of the leading steamship publications accept the view that these terms refer to oil-engined motorships, although several of the non-technical marine journals avoid any attempt at analyzing Clause Eleven.

A very well-balanced definition appears in the July issue of "International Marine Engineering" which magazine is devoted principally to steamship and steam-machinery construction. The Editor asks if the above phrases mean that the framers of the Act had in mind a particular type of machinery to the exclusion of all others, and what are the possibilities of getting a committee of representative engineers to decide as to whether the reciprocating steam-engine, the turbine, the electric-drive, the Diesel-motor, or the surface-ignition engine is the machinery thereby outlined.

"International Marine Engineering" says that a decision would have to be based upon the fuel-consumption for installations of similar power including the auxiliaries; the comparative weights and the first cost; the volume, floor space, center of gravity of the installation; the vibration due to the inertia of reciprocating parts, liability of breaking-down or stopping, ability to operate over a large range without serious loss in economy; adaptability to low, medium, and high speeds; the available supply of skilled men competent to handle the type of machinery selected, etc.

These factors certainly have to be taken into consideration, as also must be the question of actual weight cargo-capacities per ton of steel in the hull on a given voyage, and the first cost per cargo ton (not d.w. ton). But we consider that a little too much importance has been given by "International Marine Engineering" to the matter of *"the available supply of operating-engineers,"* because the first motorship built with the assistance of the Federal fund of $25,000,000.00 per annum is hardly likely to be ready for sea before the summer of 1921, and during the interim period an ample supply of men can be trained in the shops from high-grade steamship engineers, or expert stationary Diesel-engine operators can be sent to sea in steamers to receive marine experience. There is no trouble whatever to train men if only shipowners will select men to send them to one of the factory-schools recently opened by Diesel-engine builders. Unfortunately, each shipowner is waiting for the other shipowner to do it for him.

"International Marine Engineering" also draws attention to the fact that the Shipping Board should be in a position to gather some very valuable data on the relative economy of turbines and reciprocating engines. If this data can be supplemented by some information on similar vessels running under similar conditions powered with the Diesel-engine direct-connected, the Diesel-engine with electric-drive, and the turbine with electric-drive, a practical answer as to the best machinery for a given type of vessel may be obtained.

Motorship understands that the Shipping Board has carefully-compiled motorship operating information shelved away, and believe we are correct in saying that some of the most important data has never been made proper use of. The information contained therein will give the award to the Diesel-engined ship in an undisputable manner, and could with advantage be made public or available to domestic ship-owning companies without delay. We include the various compilations made by the late Diesel-engine department of the Emergency Fleet Corporation. They have rested in their pigon-holes long enough!

In view of recent assurances given us by Admiral Benson (the new chairman of the U. S. Shipping Board), we feel safe to predict that early use will be made of this valuable data.

WOODEN MOTORSHIPS

It is interesting to note that practically all of the wooden built *full-powered* American motorships have been successful in operation under ocean-going conditions, both as regards to the machinery and as to the general seaworthiness of the hull. From this one gathers that, had the Government's original fleet of wooden ships been Diesel-driven instead of being propelled by steam-machinery many of the hulls would have resulted in economical and serviceable ships, which would have a good market value today. We constantly receive reports of long voyages made by wooden motorships and the latest is that of the new wooden motorship "Balcatta" built in Seattle and placed in commission last October. This vessel recently returned to her home port after a voyage of 25,000 miles with her hull as "tight as a bottle." During this period a sum of less than three hundred dollars was spent on repairs for this ship and not a single penny was lost by damaged cargo. Her speed is slightly over 10 knots on a fuel-consumption of under 36 barrels per day, while her fuel capacity is sufficient for a radius of 12,000 nautical-miles.

FIRE INSURANCE OF MOTORSHIPS

There being no exposed flame in any part of a modern Diesel-driven steel motorship with all-electric auxiliaries it is very extraordinary that American underwriters figure fire-risk insurance rates at 6 per cent compared with 5½ per cent for oil-burning and coal-fired steel ships. It must be because underwriters are unfamiliar with the "fire-proof" qualities of modern motorships and more or less base their rates upon risks of war-time built wooden auxiliary sailing-vessels with small oil-engines of the type with which naked-flame blow-torches are used for starting and when running without load, and where the machinery installations were inadequately carried-out by inexperienced men under the pressure of owners who desired rapid delivery of vessels at any cost.

We would recommend every underwriter and every insurance broker to read the letter from Mr. Ernst Héden on page 634 of our July, 1920, issue regarding the motorship "Tisnaren." Her performance under cargo-fire difficulties should be effective in reducing the rate on motorships to 4 or 4½ per cent. Compare her record with the recent accident to the "Bergensfjord" aboard which a fuel-supply pipe broke flooding the stoke-hold with blazing-oil which could not be extinguished, but fortunately burned itself out after serious damage when the supply tank ran dry. Such an accident is liable to occur to any steamship, but not to a steel motorship unless she happened to have an auxiliary oil-fired boiler for steam heating. If the Diesel engine-room was flooded two feet deep with fuel-oil there would be nothing to ignite it like there would be with the blazing furnaces of the steamship. Incidentally, we suggest that when a donkey-boiler is installed in a Diesel ship, it shall be in a deck-house, or on a gallery or flat above the engine-room floor.

THE DIESEL-OPERATOR FALLACY

Ninety per cent of American shipowners say that they only refrain from ordering motorships because experienced engineers to operate the machinery are not available. Evidently some opposition element has been whispering honey-covered poison words into their ears, as we can emphatically state this is not the case. Experienced ship's Diesel engineers—many with excellent records—call regularly at our office seeking knowledge regarding vacant motorship positions. Frequently we communicate with motorship owners only to be told that their ships are fully manned.

Some time ago the U. S. Shipping Board selected two very capable engineers and trained them in Diesel-engine operation. Yet today there is no demand for the useful services of these men so Engineers MacMillan and Southwick are still on land. It is the intention of the Shipping Board to start a school for training engineers in the operation of merchant-marine Diesel engines and as soon as the demand comes this school will be placed in operation. Mr. J. D. Norton, of the U. S. Shipping Board, 45 Broadway, will be glad to hear from any shipowners desiring Diesel engineers. He advises us that at present there is no demand for such men.

For several years the McIntosh & Seymour Corporation have had a Diesel engine training school and many good men have been produced. Other American engine-builders also train men.

Progress in Marine Diesel-Engine Building at Krupp's During the War

A Great Number of 1,250 Shaft H.P. Merchant-Ship Four-Cycle Type Diesel-Engines Now Under Construction. Double-Acting, Port-Scavenging, Two-Cycle Sets for Powers Over 4,000 Shaft H.P.—Four-Cycle Sets of 19,000 Shaft H.P in 12 Cylinders Possible With Super-Compression

By OTTO ALT

Chief-Engineer, Oil-Engine Dep't, Krupp's Germania Works, Kiel, Germany

Part II

(*Continued from page 606, July, 1920, issue*)

The chief object of the injection is to atomize the fuel into the smallest possible particles. Besides the velocity of the fuel-particles, their spacial distribution into the combustion chamber is of decisive importance. These conditions are fulfilled by the injection with compressed-air. In consequence combustion here is perfectly invisible up to a mean-indicated pressure of 9 atm. (130 lbs. sq. inch). With a normal pressure of the spraying air from about 65-80 atm. (930-1,140 lbs. sq. inch), the mixture of fuel and air will enter the working cylinder with a speed of 250-300 meters per second. By a well-informed atomizer, the fuel is dissolved into finest particles.

If the cams be suitably shaped and the nozzle has the proper area of passage, the mixture will be temporarily and spacially distributed in such a manner that combustion takes place at nearly constant-pressure. These conditions can scarcely be reached with solid-injection. To obtain the high fuel-velocity of 250 to 300 meters per second, which seems necessary for good combustion, a fuel-pressure of about 300 atm. (4,300 lbs. sq. inch) and more must be employed. The quantity of liquid-fuel forced in with solid-injection is only 1/25 of the quantity of the air-fuel mixture injected by the compressed-air injection method. The quantities are therefore so small that to control them must be very difficult.

The engines of the solid-injection type for this reason show explosive combustion and intensive after-burning, and it seems to be very difficult to realize smokeless combustion with high-speed engines and with dynamo-driving engines fitted with sensitive governors. Moreover the fuel-pumps for solid-injection have to be of special design and first-class workmanship.

Considering the above said, it is remarkable that in the moment when the compressor is eliminated in the Diesel oil-engine, it is applied to the hot-bulb type of surface-ignition oil engine. Recently the well-known engines of Bolinder are being delivered with an air-compressor, the air being employed not only for cooling the hot-bulb, but also for atomizing the fuel. In my opinion, the solid injection is applicable only for low powered engines running at nearly constant speed and constant load.

The before mentioned difficulties are surmounted much easier by the working process of the *Steinbecker-Motor*. Here the necessary high velocity of the fuel-spray and the consequent atomizing of the fuel is effected by the kinetic energy of the air-gas mixture rushing through the shot-channel into the combustion space. In addition the gasification is supported by the high temperature of the retort, while the fall of temperature consequent to the expansion of the cold spraying air in the air injection method, is avoided.

The figs. 10-13 show some indicator-diagrams taken from an experimental engine fitted with the *Steinbecker arrangements.* The exhaust at all loads was invisible.

On account of these favorable results, Krupp has taken a license from the Deutsche Automobil-Konstruktions-Gesellschaft at Berlin, the owners of the Steinbecker patents. Krupp will first take up the building of stationary oil-engines fitted with the Steinbecker apparatus.

The injection being once started in one of the three described ways the evaporation and gasification of the fuel takes place immediately. It is as yet not sufficiently explained how this process takes place before and after the ignition of the fuel. Professor *Neumann*, of the Technical High-School in Dresden has gasified in an electrically-heated cup several fuels for Diesel oil-engines under different pressures. He determined the chemical composition of the gases, but it is not proved whether vaporization and gasification of the fuel takes place in the same manner in the engine as in the cup. At any rate, the remarkable distinctions between the different fuels, which are noticeable during the combustion in the actual engine, were not fully observed. This question leads us to discuss the composition of the different fuels.

The fuels chiefly employed for oil-engines are those obtained from mineral oils, lignite and pit-coal. The fuels from the mineral oils are gasoil, from lignite paraffin-oil, and from pit-coal a special sort of tar-oil which has of late been distilled from the so-called low temperature tar. These oils consist chiefly of aliphatic hydro-carbons, whilst the ordinary tar-oils from tar produced in gas-works and coke-ovens are a mixture of naphthalene and anthracene, and consist chiefly of aromatic hydro-carbons. The first might therefore, be called aliphatic, the latter aromatic fuels.

The *gasifications curves* of these two classes of fuels are very different. After the researches of Neumann paraffin-oil is completely gasified at 480° C (896° F), while only 5 per cent. of the ordinary tar-oil are gasified at this temperature, 540° C (1,004° F) being necessary for complete gasification. Therefore, it is clear, that the running of automobile motors with tar-oils would be a very difficult problem.

According to our present knowledge ignition begins after the gasification. Formerly we thought is possible to find the ignition temperature in the engine by determining the ignition-temperatures of the fuels themselves.

Holm and Constam and Schläpfer made such experiments, which were repeated in the chemical laboratory of Krupp in Essen. In the following we give the ignition-temperatures found out by Constam and Schläpfer in a crucible of platinum in air at atmospheric pressure.

Fuel	Ignition-Temperature °Cent.
Gas-oil	440-480
Paraffin-oil	440-480
Tar-oil	590-630
Anthracene-oil	650

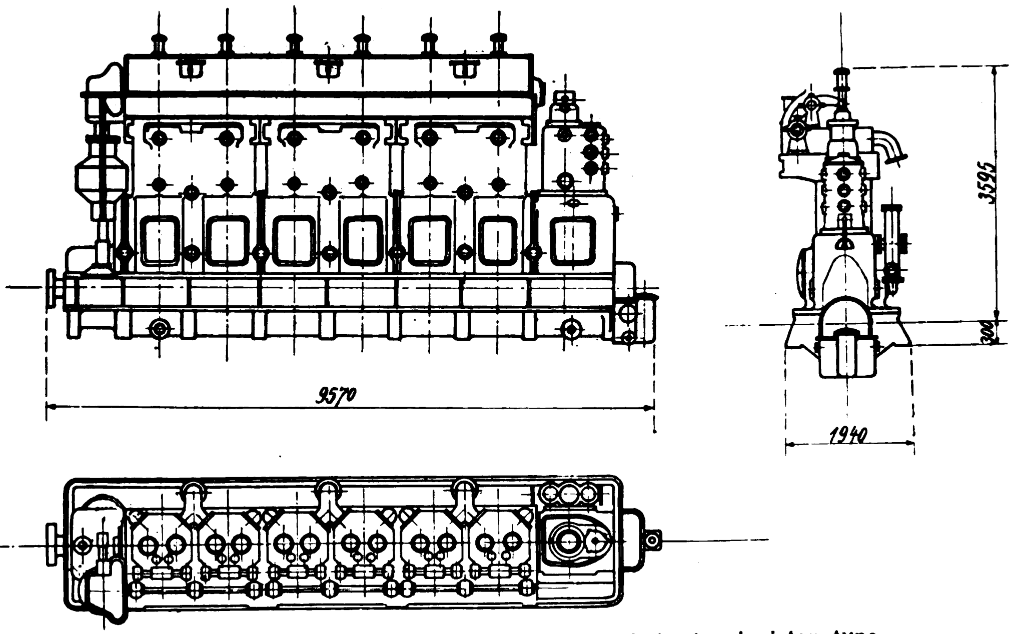
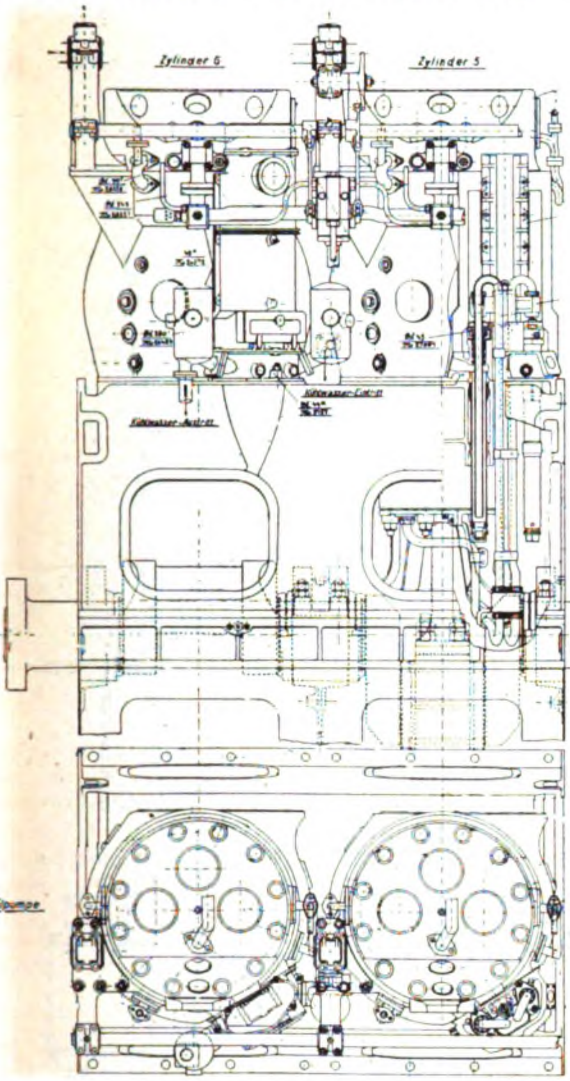


Fig. 6—750 B.H.P. four-cycle marien Diesel engine of the trunk-piston type

In comparison the following table shows the ignition temperatures of the gases: hydrogene, methane, ethane and carbon monoxide as determined by Dixon and Coward in air at atmospheric pressure. The above gases were



found as constituents of fuels gasified by Prof. Neumann.

Gas	Ignition-Temperature
Hydrogene	580-590
Methane	650-750
Ethane	520-630
Carbon monoxide	644-658

Since these latter ignition-temperatures generally are higher than those in the engine we must assume that the gasification takes a different course in the engine, and that the ignition-temperatures in the engine are more in accordance with those found by Constam and Schläpfer, than was formerly supposed.

The following table shows the temperatures at the end of the compression for Diesel-engines running at full load and for different end pressures:

Pressure at the end of compression		Temperature at the end of compression	
kg. cm²	lb. sq. inch	°Cent.	°F.
10	143	340	644
15	214	410	770
20	286	470	878
25	357	515	960
30	429	560	1040
35	500	595	1104
40	570	625	1157
45	643	655	1212
50	714	680	1257

The table shows that for *gas-oil* the ignition-pressure is about 20 kg. cm² (286 lb. sq. inch), whilst for *tar-oil* this pressure is 35-40 kg. cm² (500-570 lb. sq. inch). In practice the ignition-pressures are a little higher on account of the cooling effect of the spraying air. When using *tar-oil*, it is necessary to increase the compression to 40-45 kg. cm² (570-743 lb. sq. inch), or to initiate the ignition of hot parts of the combustion-chamber by ignition-oil.

Ignition being once started the course of *combustion* depends on the fineness of atomizing, and on the temporal and spacial distribution of the fuel, not considering the effect of turbulence in the combustion chamber.

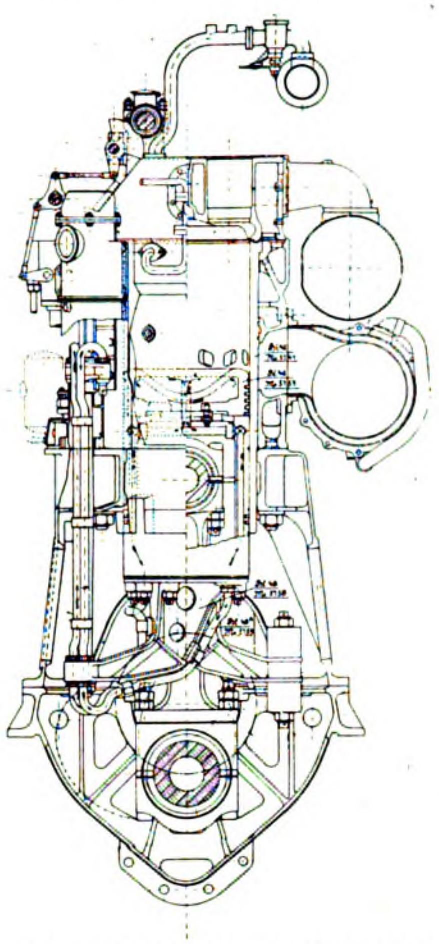


Fig. 7—1650 B.H.P. engine. The telescopic pipes being entirely outside the crank pit

Our only means for influencing combustion are, besides the control of the injection-air pressure, the shaping of the fuel-cams and the variation of the free passages in the atomizer and in the nozzle.

The secret of perfect combustion is to be found in the proper sequence of these areas of passage. It is clear, that in the short time of injection of some hundredth of a second, and owing to the high velocity of the fuel, this task is a very difficult one. It is no wonder that often the chaos of empirical work is predominant on the testing-beds of oil-engine manufacturing works, and that experiments with atomizers are for long periods the chief occupation of the test-bed engineers.

After-burning, that means the ignition of parts of fuel during the expansion, depends in the first place on the rate of combustion. From the researches of Dugald Clerk and Hopkinson we know the high influence of motion on the rate of combustion. These experimenters found that the turbulence effected by the rush of air into the cylinder increases the rate of ignition very much. This turbulence is considerably intensified by the spraying air in the Diesel-oil-engine working with compressed air, and acts as another cause for the better combustion with these engines.

Heat Stresses

Till now, no marked progress has been made in preventing the cracking of cylinder covers and pistons by calculating the heat stresses and experience is still the only guide. Thus it has been pointed out that heat-cracks appeared on parts having too thick walls, or being insufficiently cooled. The first step was to avoid such accumulation of material and to improve cooling by directing the flow of water, and by properly dimensioning the water passages in the cooling space.

By these means the life of cylinder covers has been remarkably prolonged. Further improvements were made by dividing the hot parts of the engine to allow for unrestrained expansion of the material. For engines with very high heat-stresses, i.e., large two-cycle engines of the single and double-acting type, heat-cracking can be prevented only by employing special water-cooled chambers and rings.

In fig. 14, showing the section through the cylinder of a 1,700 B.H.P. four-cycle submarine-engine of the Germaniawerft, we see

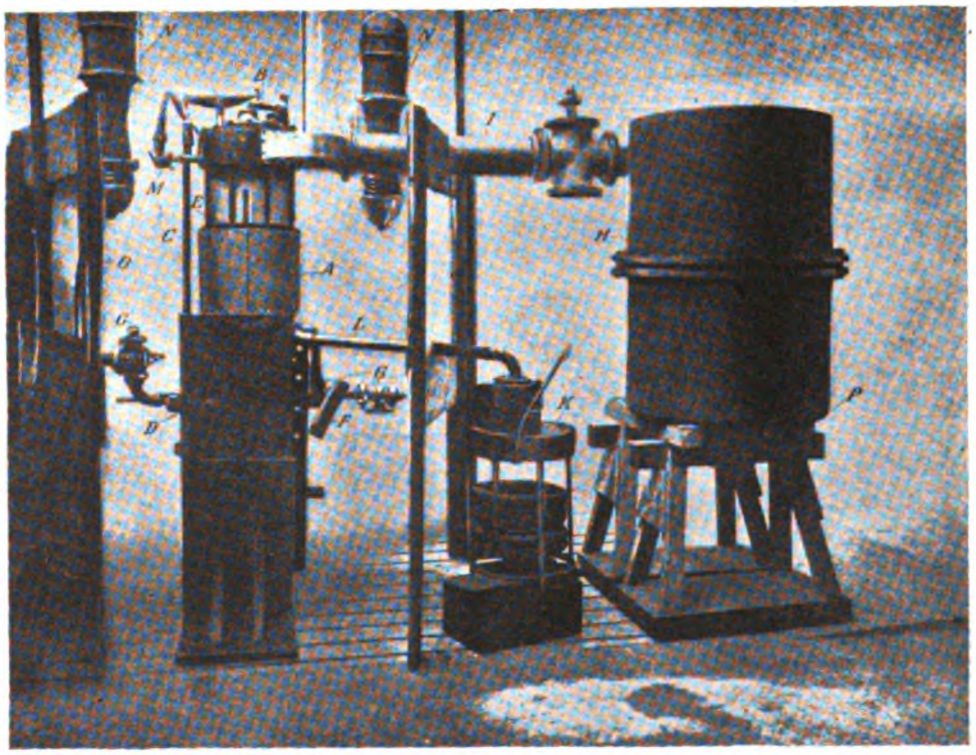


FIG. 8—APPARATUS FOR INVESTIGATING THE FLOW OF THE SCAVENGING AIR
A.—Guide Cylinder with Outlet-Ports. B.—Cylinder Cover with Three Scavenging Valves. C/D.—Valve Gearing with Cams. E.—Pointer Showing the Position of the Piston. F.—Balance Weight for Moving the Piston. G.—Air Cock and Air Pipe Under the Piston. H.—Scavenging Air Receiver. J.—Smoke Distributing Pipe. K.—Fireplace with Smoke Producer. L.—Smoke Pipe to Cylinder. M.—Ejector with Air Pipe. N.—Arc-Lamps. O.—Protecting and Reflecting Screens. P.—Scavenging Air (and Smoke) Pipe Behind the Receiver

the means employed to avert heat-cracking, the cylinder consisting of a cooling-jacket of cast-steel with a separate liner of cast-iron, the piston being divided into a lower part of cast-iron and an upper oil-cooled part of steel. The cylinder cover of cast-iron has two separate water jackets in order to properly direct and ensure a high velocity of the water.

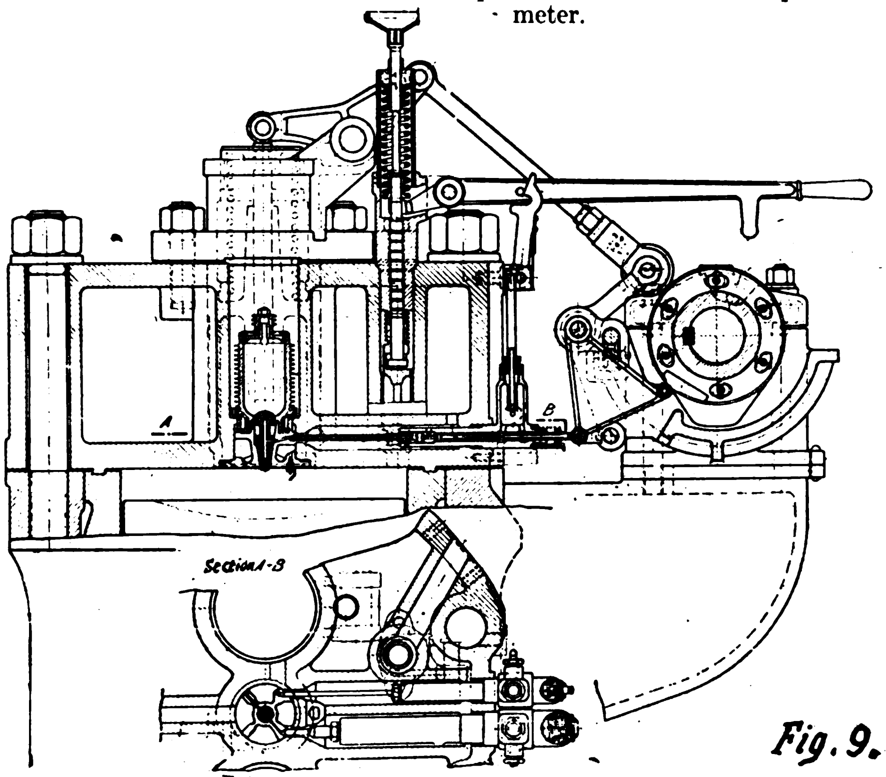


Fig. 9.

Fig. 9—The Steinbecker engine cylinder-head

Fig. 15 represents the uncooled piston of a stationary engine, having a special mushroom-formed head to allow for an unrestrained expansion of the hottest part of the piston and to make it easily replaceable. When the engine is running the mushroom head begins to glow and thus helps the ignition of slow-burning fuels such as tar-oil.

The quantity of heat generated per square-meter of surface of the combustion-chamber in one hour, seems to me a simple criterion for the heat stresses and here from for the design of the hot parts of the engine in order to obtain a sufficient durability of these parts. In my paper above mentioned, for this quantity of heat I have given the following

$$q_o = \partial . q . n . D . p_e \quad (1)$$

In this formula

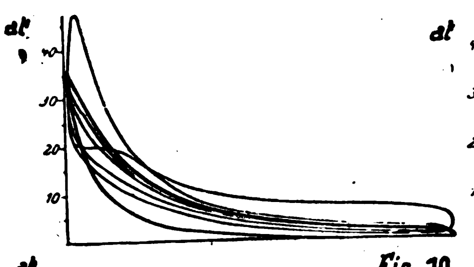


Fig. 10.

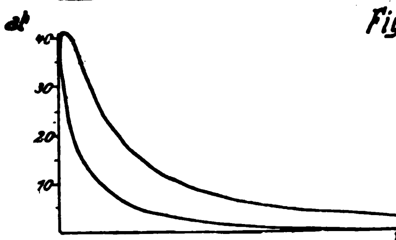


Fig. 11.

Fig. 10—Indicator diagram (starting diagram) of the Steinbecker engine
Fig. 11—Indicator diagram at normal power of the Steinbecker engine

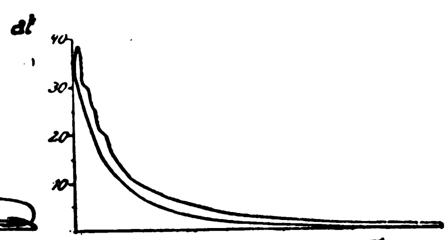


Fig. 12.

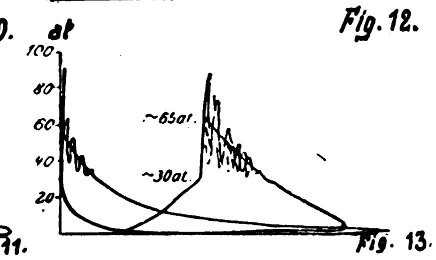


Fig. 13.

Fig. 12—Indicator diagram at no load of the Steinbecker engine
Fig. 13—Indicator diagram of the retort of the Steinbecker engine

q in metric thermal units is the quantity of heat passing through one square-meter of the surface of the combustion chamber in one hour, or the specific heat-load.

∂ is a co-efficient, depending on the number of working cycles, on the stroke-bore ratio and the duration of the injection.

q in metric thermal units is the quantity of heat per B.H.P. passing through the surface of the combustion chamber.

n is the number of revolutions of the engine per minute.

D is the bore of cylinder in meters.

p_e is the mean effective pressure in kg. sq. meter.

According to the trials of the Germaniawerft the value q for two-cycle as well as four-cycle engines at full load is about 500-550 thermal units per B.H.P. an hour. It seems to be nearly independent of the size of the engine.

From the formula (1) we find a specific heat-load q^o for the 1,650 B.H.P. two-cycle submarine engine fig. 3 of 302,000; for a two-cycle merchant vessel engine with a bore of 575 mm. and a stroke of 1,000 mm. 163,000; for the above mentioned 1,700 B.H.P. four-cycle submarine engine 244,000; and for the 1,250 B.H.P. four-cycle merchant vessel-engine (fig. 5) 91,000 thermal units per square meter. We see that, whilst for submarine engines of equal power the specific heat-load of two-cycle engines is nearly 20% higher than that of four-cycle engines, for merchant vessel-engines the specific heat-load of two-cycle engines is nearly twice as high as that of four-cycle engines.

Therefore, the cylinders, cylinder-covers and pistons of two-cycle engines of merchant vessels must be of special construction to attain the same durability as those of four-cycle engines. Heat-cracks of two-cycle engines are therefore not surprising, all the more so as the mean-indicated pressure of two-cycle

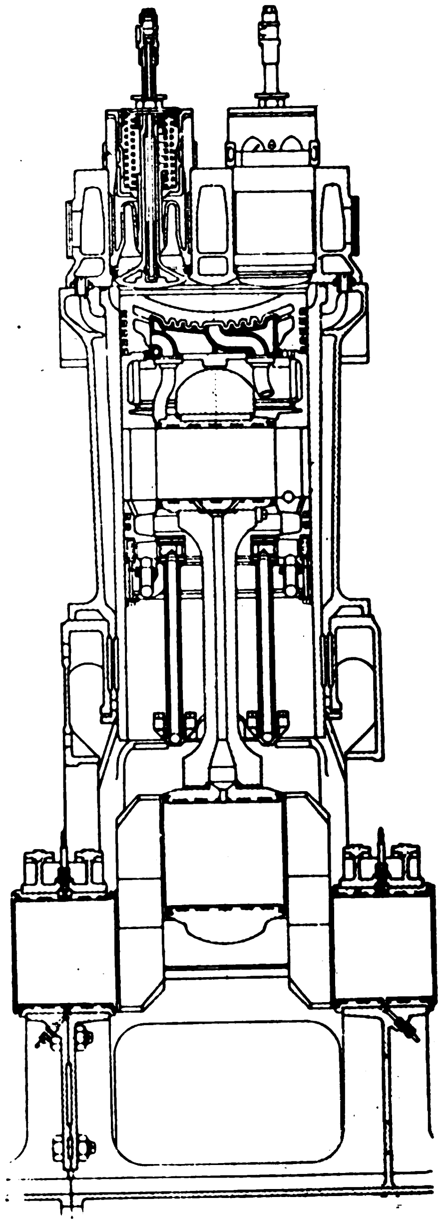


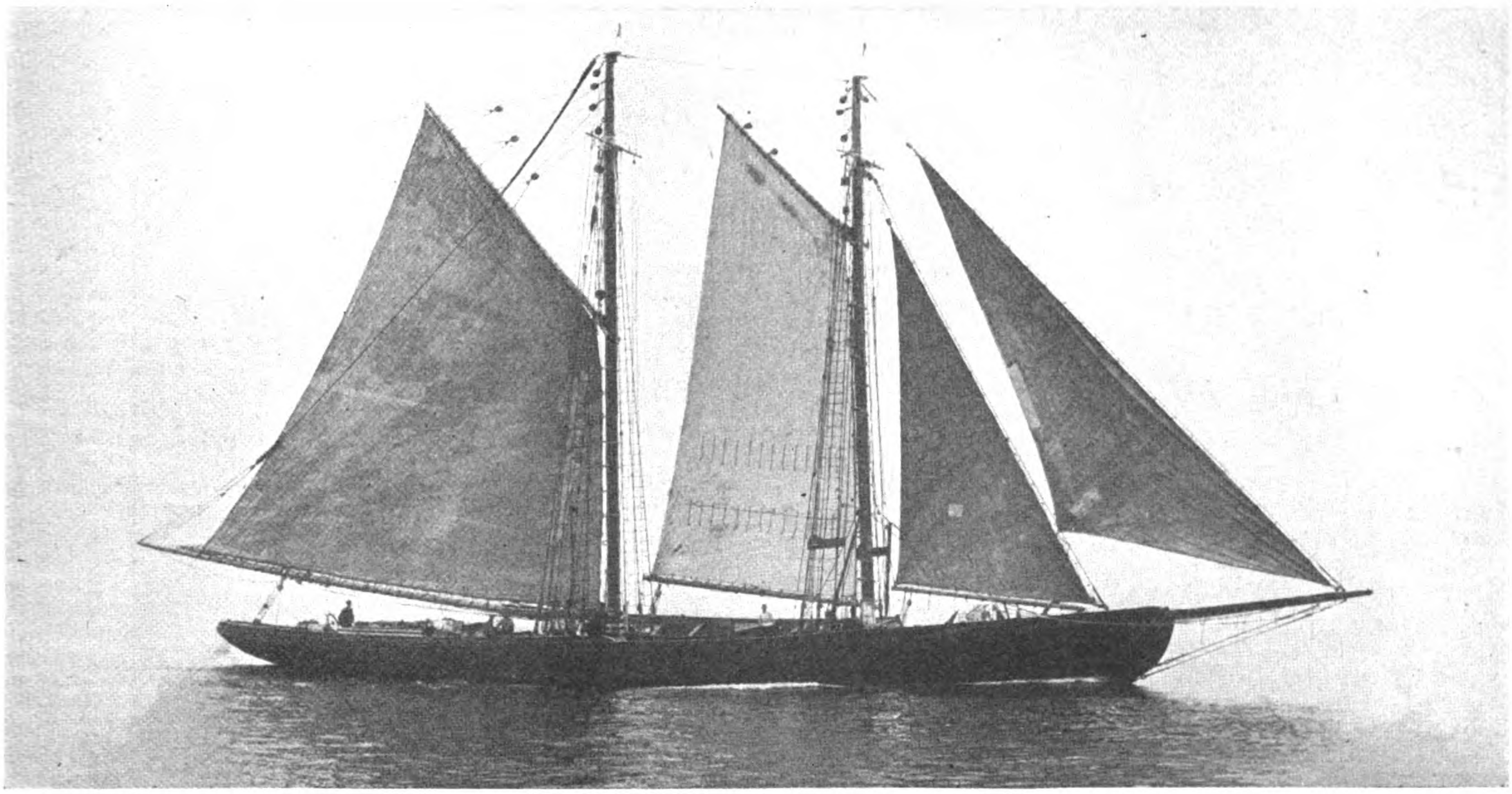
Fig. 14—Section of 1,700 B.H.P. four-cycle submarine engine

engines has often been higher than that of four-cycle engines.

Owing to the lower specific heat-load of four-cycle engines piston-cooling can be dispensed with up to much higher powers than in two-cycle engines. That is one of the greatest advantages of the four-cycle engine. (In my previously mentioned paper, the formula [1] has been employed to examine the constructional arrangements of other parts of oil engines with regard to heat stresses).

A great deal of information was gained by the measurement of temperatures in the walls of the cylinder, cylinder-cover and piston with thermo-electric elements by the Germaniawerft. The experiments on a 1,700 B.H.P. four-cycle submarine engine gave the following temperatures: in the middle of the cylinder-cover between the admission, the exhaust and the two fuel valves at the fire-side about 290° C. (554°F.), at the waterside about 140° C. (284° F.), in the upper part of the cylinder liner at the fire-side also about 290° C. (554°F.), on the outside (being not directly water-cooled) about 200°C. (392°F.) The last mentioned difference of temperature gives an explanation for the high reliability of engine cylinders having separate liners, as shown in fig. 14.

(To be concluded in our September issue)



The mackerel motor-schooner "Stilletto," which has been in successful operation for three years

Mackerel Schooner "Stilletto"

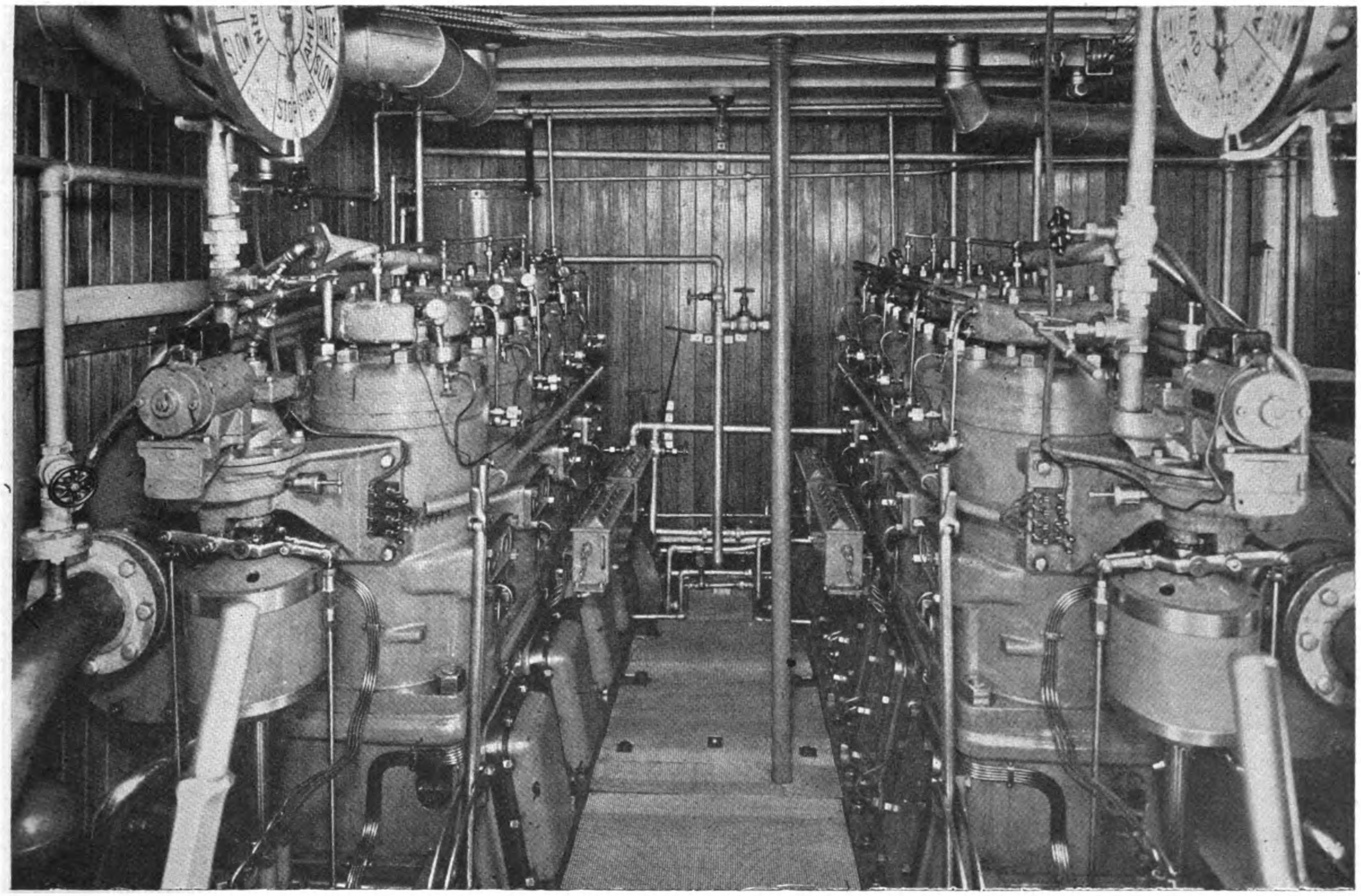
Oil-Engined Fishing Vessel Completes Three Years' Service Without Trouble

Up to the present time only two marine heavy-oil engine companies have made vigorous efforts to standardize this class of motive power in the Atlantic Coast fishing industry, so, as a consequence, the number of craft so fitted is limited. But, owing to the increasing cost of gasolene and the difficulty of obtaining kerosene, there is a tremendous market for those oil-engine builders who will energetically enter this field and who are willing to spend a little money and time carrying out a regular campaign.

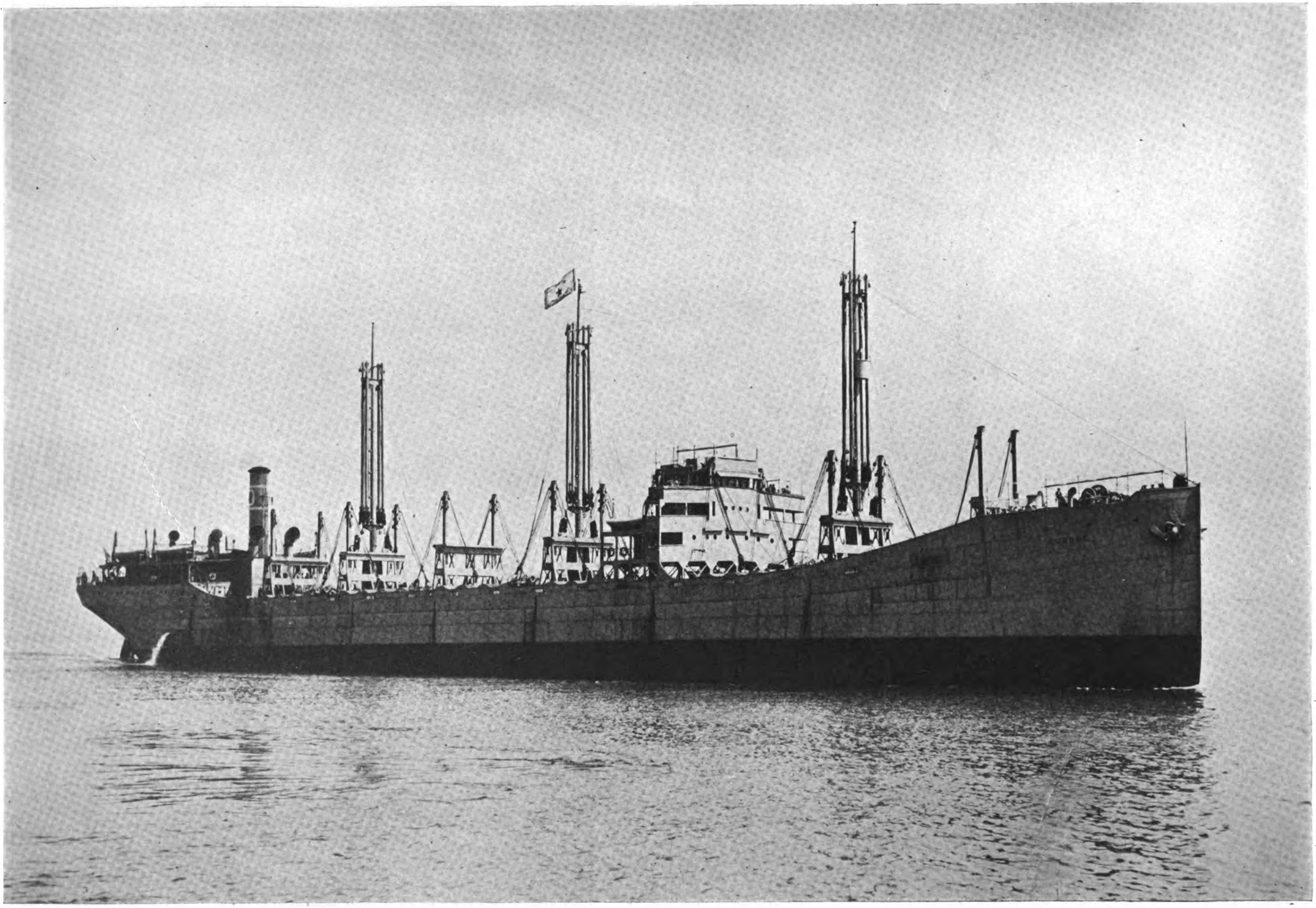
For several years the Fairbanks Morse Company have centered their energies on the fishing industry of both coasts, and have received many orders for propelling and auxiliary sets for these boats.

On this page are given excellent illustrations of the motor-driven mackerel-schooner "Stilletto," which recently completed three years' service. In a letter to the builders of the engines the William H. Jordon Vessels Company, fish merchants of Gloucester, who are her owners, state that "no trouble has been experienced with the propelling-engines during that period." This speaks for itself.

The "Stilletto" is of 136 tons register, and is fitted with twin four-cylinder, two-cycle type surface-ignition Fairbanks Morse heavy-oil engines of 60 shaft h.p. each, which give her a maximum speed, without sails, of 8 knots. There also is a 6 h.p. hoisting engine of the same make on deck. Her length is 105 ft. 7 in. by 24 ft. 8 in. breadth and 11 ft. 7 in. depth.



Engine-room of a small vessel showing twin Fairbanks-Morse surface-ignition oil-engines



OUR LARGEST "ALL-AMERICAN" DIESEL-DRIVEN MOTORSHIP

"CUBORE," an ore-carrier of 11,500 tons d.w.c., owned by the Ore Steamship Company, New York, and now on her maiden voyage to Cuba. She is a single-screw motorship built by the Bethlehem Shipbuilding Corporation, Ltd., at their Fore River Plant, and equipped with a six-cylinder 3,200 I.H.P. two-cycle type Diesel oil-engine constructed by the Bethlehem Steel Company from design by Arthur West. The "Cubore" is the largest and highest-powered "All-American" motorship yet built. Successful sea-trials have been run. She is only exceeded in power and size by the U. S. Navy motor tanker, the two-cycle Diesel engines of which were built in New York from modified German designs.

The Largest All-American Motorship

"Cubore" an 11,500-ton Single-Screw Two-Cycle Diesel-Engined Ore-Carrier of 3,200 I.H.P.

By the time this appears in print the new 11,500 tons d.w.c. American motorship "Cubore" will have started on her maiden voyage to Cuba. We are advised by the Bethlehem Shipbuilding Corporation, Ltd., that her trials have been successfully run, but no results or figures have yet been given out. References to this interesting vessel have been made several times in the columns of "Motorship" but she and her Diesel-machinery have been built in stricter secrecy than ever adopted with any motorship yet built in this country or Europe.

The "Cubore" bears the distinction of being the largest and highest powered "All-American" motorship yet completed, everything in connection with her design and construction having been carried out in the United States. Her engine was designed by Mr. Arthur West of the Bethlehem Steel Co., South Bethlehem, Pa., and was designed to develop 3200 I.H.P. from six-cylinders at 105 revolutions per minute.

It is of the two-cycle crosshead type with valve-in-the-head scavenging and we understand is along the general lines of the M.A.N. (Nürnburg) Diesel engines built for the "Maumee" at the Brooklyn Navy Yard and the M.A.N. engines built by Blohm & Voss, of Hamburg, Germany.

Revelation of test-results and the results of the first year's operation of the "Cubore" should afford considerable useful information, because up to the present time valve-in-head scavenging has not been very successful with such large merchant-ship engines as are in service, and troubles arising from the same were partly the cause of the removal of the Krupp Diesel-engines from the Standard Oil Co.'s tanker "Glenpool." Therefore, if Mr. West, unaided by European skill and experiences has succeeded where others longer in the industry have been halted, his reputation as one of the foremost of American gas-engineers will follow him into the Diesel engine field, and he will be entitled to every bit of credit that will rightly be due him.

The question of port-scavenging versus valve-in-head scavenging has been discussed in "Motorship" by the leading designers and engine-builders of the World. The chief-engineer of Krupps is now against the latter, as are Sulzer Freres, while Schneider & Co. of France and Nordbergs of Milwaukee are strongly in its favor. With the exception of the excellent stationary engines built at Nordberg's plant few slow-speed crosshead engines of the valve-scavenging type have been built, especially for mercantile-marine service, since the war, so it is not fully wise to take past experiences as a criterion. It is to be hoped that Mr. West has fully solved the problems relating to the design. Perhaps it is unfortunate that the Bethlehem Company have thought fit to withhold shop and ship test-reports at this time.

The "Cubore" will be operated by the Ore Steamship Co. of New York, for carrying ore from the Bethlehem Steel Corp.'s Cuban properties to their plants in the U. S. A. Her hull was built at the Fore River yard of the Bethlehem Shipbuilding Co. She has the following dimensions:

Dead-weight-capacity	11,500 tons
Length (O.A.)	469 ft., 0 in.
Length (B.P.)	450 ft., 0 in.
Breadth (M.D.)	57 ft., 0 in.
Depth (M.D.) to upper deck	37 ft., 0 in.
Engine speed	105 R.P.M.
Power	3,200 I.H.P.
Type of ship	Single-Screw

Her auxiliaries are steam-operated, a Scotch boiler of 1800 sq. ft. heating-surface being installed from which steam is supplied at 140 lbs. pressure.

Sixteen Diesel-Driven Tugs

Fleet of Sulzer & Polar Oil-Engined Craft Built for French River Service by Ministry of Public Works

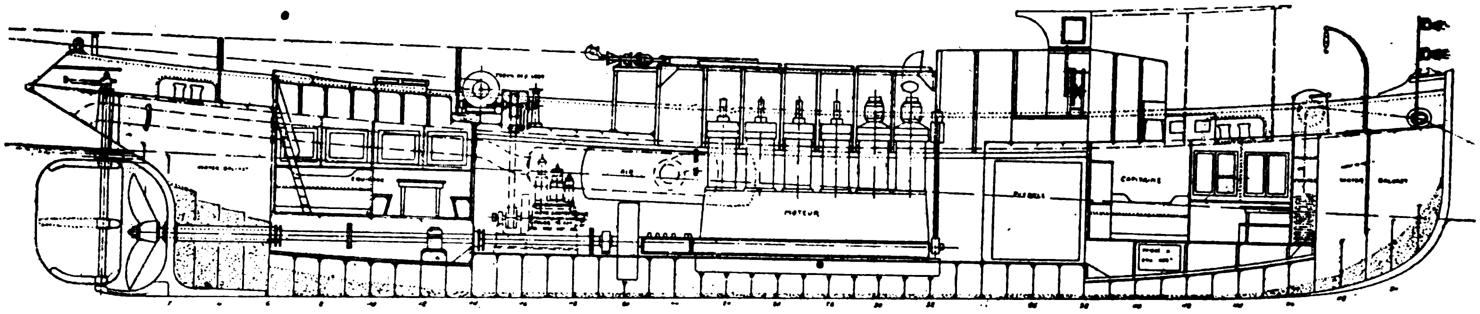
When we published our article on Diesel engine and motorship development in France in our December, 1919, issue, no reference was made to a fleet of powerful oil-engined motor-tugs built during the war for river service by order of the Minister of Public Works. Such a large fleet of craft of this type should be of interest because we do not suppose that there are more than two-hundred Diesel and surface ignition oil-engine powered tow-boats in service throughout the world.

Ten of these little vessels were propelled by Sulzer two-cycle type Diesel-engines of 420 shaft h.p. built in Switzerland and installed by the Forges et Chantiers de la Mediterranee, 25 Boulevard Malesherbes, Paris, licensees of Sulzer Frérés, and who constructed the steel hulls. These ten boats are known as the "Morin" class and have the following dimensions:

Displacement	145 tons
Length (O. A.)	28 metres
Length (B.P.)	26 metres
Breadth (extreme)	5.08 metres
Draught	2.90 metres
Fuel-capacity	12,000 litres
Rated power	420 shaft h.p.
Maximum power	640 i.h.p. (455 shaft h.p.) at 213 r.p.m.
Mechanical efficiency at maximum power	71%
Normal fuel-consumption	80 litres per hour
Maximum fuel-consumption	100 litres per hour

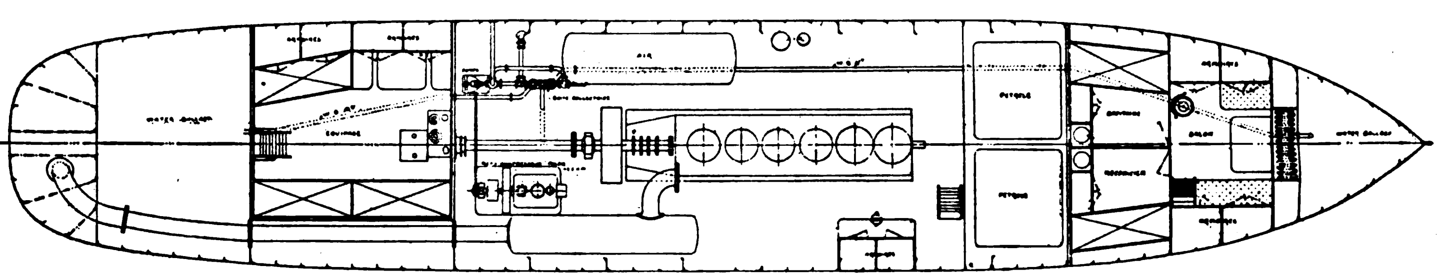
For the auxiliary air-compressor and electric lighting the "Morin" class of tugs are fitted with a 12 b.h.p. Diesel oil-engine. Six of the fleet of tugs were Polar Diesel propelled. They were built by the Société Anonymé des Ateliers et Chantier de la Loire, 11 bis Boulevard Haussmann, Paris, and are almost identical in design and dimensions with the Sulzer-equipped boats, except that the engines are of a little less power, namely, 350 shaft h.p., with the result that the displacement of these tugs is only 140 tons. The Polar Diesel-engines have four working cylinders, 360 mm bore by 530 mm stroke, and two scavenging cylinders in line. They develop their rated power at 200 R.P.M. on a weight of 34 tons. The auxiliary machinery weighs 6 tons. These sixteen motor vessels, says the "Bulletin Technique du Bureau Veritas," have been in service of the Office National de la Navigation a Rouen.

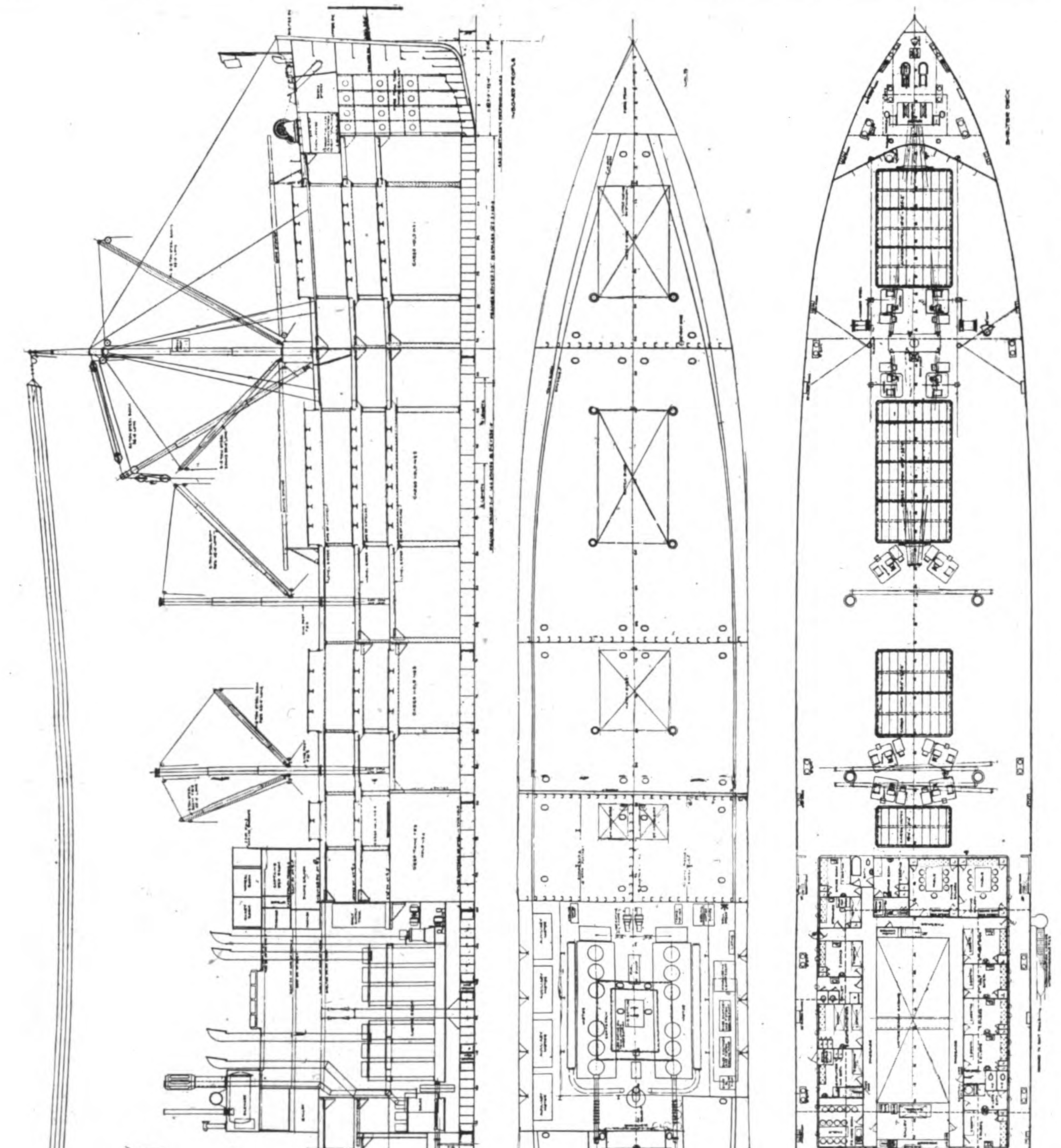
We understand that some Diesel-engined tugs of similar size have been built, or engined, by the Société des Moteurs Chalèassiere, of St. Etienne, and two-cycle Sabathé motors of 350 shaft h.p. at 200 R.P.M. are installed. But we do not know if they were for the Minister of Public Works or for private owners. They are known as the "Cigale" class.



French motor-tug of the "Avre" class

Powered with a 350 shaft h.p. Polar Diesel-engine





General arrangement plans of the two 11,200 tons d.w.c. Diesel-driven motorships on order for the American-Hawaiian Steamship Co. of New York

American-Hawaiian Co.'s Motorships

General Details of the Two 16,500 Tons Displacement Diesel-Driven Vessels Now on Order

SOME years ago the American-Hawaiian Steamship Co. of New York were the pioneer shipowners in the United States to adopt oil-firing under the boilers of their steamships, and they recently maintained their position as leaders of progress in the domestic ship-operating field by ordering two large Diesel-engined motorships from the Merchants Shipbuilding Co., the first official announcement regarding which was made in our issue of March, 1920. One or two slight changes have been made in connection with the preliminary arrangements of these freighters, and we now are able to publish the plans as finally adopted.

They are the largest sister motorships now on order in America, and the complete Diesel machinery will be built by Wm. Cramp & Son Ship & Engine Company of Philadelphia, Pa., from designs by Burmeister & Wain of Copenhagen. In fact the propelling-engines will be duplicates of the six-cylinder, four-cycle type pair now being installed in the cargo-motorship "William Penn" completing for the U. S. Shipping Board at the Pusey & Jones Shipyard, Gloucester, Pa., which engines by the way, were purchased nearly two years ago, but for some "unknown" reason were not fitted in earlier-built hulls, once again indicating that somewhere a strong influence is still at work hampering the adoption of the economical Diesel drive. Yet, the future success of America's merchant-marine in overseas service rests with the economical oil-burning motorship and not with oil-fired steam.

There are many signs that the encouraging step taken by the American-Hawaiian Steamship Company is already having its effect on other steamship lines and that a number of orders will shortly follow. One of the greatest companies in America is now planning a big fleet of motorships which they will build for their own use, and we expect to make an authorized announcement in the next issue of "Motorship." It will afford a great stimulation to the industry. One thing is certain and that is—the American-Hawaiian Steamship Co. will order no more oil-fired steam-driven cargo-vessels.

Their new motorships will be classed 100 A1 at Lloyds, and will have the following features:

Displacement (loaded)	16,500 tons
Displacement (light)	5,300 tons
Weight-cargo Capacity (on 10,000 miles voyage)	10,460 tons
Dead-weight-Capacity	11,200 tons
Total Cubic-Capacity	587,200 cu. ft.
Speed	11.5 knots
Daily Fuel Consumption	15 1/3 tons

Before proceeding with the dimensions we desire to draw the attention of steamship owners that, while the loaded displacement of either vessel is but 16,500 tons she will carry 587,200 cubic-feet of cargo (or 10,460 tons) in addition to a proper supply of fuel, water and stores, at 11½ knots speed on a daily-consumption of 15 tons of fuel.

Outlined in these figures are the chief advantages of a motorship in the proverbial nutshell. Because, compared with a steamship of the same loaded-displacement and speed she carries at least 12 per cent more weight-cargo or about 10 per cent more bulk-cargo, and only uses one-third the amount of fuel to do it. Yet the dead-weight capacity (an obsolete term) is almost the same.

Shipowners can compare these figures with their own steamers, and we will be glad if one of our interested readers will send us some actual operating figures dealing with an oil-fired turbine or reciprocating steam-vessel of this size and speed. The dimensions of the motorships under discussion are as follows:

Length (O. A.)	461 ft., 10 in.
Length (B. P.)	445 ft., 0 in.
Breadth (moulded)	59 ft., 8 in.
Depth (moulded)	39 ft., 0 in.
Mean Loaded Draught	28 ft., 6 in.
Cubic Capacity of Hold	552,000 cu. ft.
Cubic Capacity of Deep Tank (used solely for cargo)	880 tons or 35,200 cu. ft.
Fuel-Capacity	1,200 tons
Cruising-Radius	21,000 nautical miles
Drinking-Water	87 tons
Shaft horse-power	3,600
Indicated horse-power	4,500
Engine Speed	115 R.P.M.
Daily Lub. Oil Consumption	12 gallons
Port Fuel-Consumption	1¼ tons
Length of Machinery Space	55 ft., 6 in.
Engine Cylinder Bore & Stroke	740 mm. x 1150 mm.
Auxiliary Diesel Engines	Four of 100 b.h.p.

Special attention has been paid to rapid handling of cargo, as these vessels will be able to load and unload much quicker than the average European motorship, and the consequent shorter stays in port may enable her to make an additional one-way voyage each year and so more than make-up for the higher wages paid to her crew. The auxiliary Diesel engines will consist of four units of 100 b.h.p. each, coupled to electric-generators, for furnishing power to the cargo-winches, steering-gear, pumps, auxiliary air-compressor, lighting, etc. There will be fourteen of 5 tons, and two 30 tons electric cargo-winches and they will work at 150-200 feet per minute. In the engine-room there will be a small donkey-boiler for steam heating of the ship.

Interesting News and Notes from Everywhere

THE DOXFORD MOTORSHIPS

Altogether Wm. Doxford & Sons, Ltd., of Sunderland, England, are building four standardized Diesel motorships of 12,750 tons loaded displacemen and of 9,350 tons d.w.c. each.

DANISH 4,400 TON MOTORSHIP LAID-DOWN

A motorship of 4,400 tons has been laid-down at A. P. Mollers shipbuilding yard, Odense. Denmark. Burmeister & Wain will supply the Diesel engines.

THE MERCHANT SHIPPING WIRELESS TELEGRAPH ACT

The above Act states that all motorships and steamships over 1600 tons gross shall carry a wireless telegraph apparatus and one or more operators. American vessels entering British ports are affected by this order.

BREWERS PURCHASE SUBMARINE ENGINES

A set of German submarine Diesel-engines have been installed in the brewery of Watney, Coombe & Reid, of Pimlico, England. German submarine Diesel-engines are also being used for pumping beer by a firm in the Midlands.

PACIFIC STEAM NAVIGATION CO.'S MOTORSHIPS

The three 6,800 tons gross motorships on order with Harland Wolff for the Pacific Steam Navigation Co. have been named "Lobos," "Losada" and "La Paz." The latter was launched last May as announced in the July issue of MOTORSHIP.

SMITS ADOPT WERKSPOOR LICENSE

J. Smits & Sons, shipbuilders of Kinderdyke, have acquired a Werkspoor marine Diesel-engine license and will build some of the Diesel engines for the motorships which they have under construction for the Otto and Thor Thoresen Line of Christiania.

THREE MOTORSHIPS FOR GYLFE STEAMSHIP COMPANY

Referring again to the motorships for the Gylfe Steamship Company (Denmark), we learn that this company has three Diesel motorships on order; namely, two of 9,000 tons d.w.c. in England, and one of 6,000 tons d.w.c. in Denmark. The capital of the Company is 7,500,000 kroners. Recently the Rollo Steamship Company was transferred to the Gylfe Company.

RUSSIAN DIESEL TANKER OF 12,500 TONS

News takes a long time to get out of Russia. We have just heard that in 1917 a Diesel-driven oil-tanker of 12,500 tons displacement was completed by the Nicolaeff Engineering & Shipbuilding Co., Nicolaeff, River Bug, Russia. The vessel has a speed of 10½ knots. Also the Russian Shipbuilding Yard, Nicolaeff, built and put into commission 50 twin-screw Diesel-driven motor barges of 400 tons each for landing troops.

CHARGEURS REUNIS MAY BUILD TWO DIESEL ELECTRIC PROPELLED MOTORSHIPS

Plans are well advanced for two large motorships which are proposed to be laid-down in Franch by the Chargeurs Reunis. A point of interest in connection with these vessels is that they will be Diesel-electric propelled, three sets of Diesel-driven dynamos supplying current to the propelling motors and all auxiliaries. The engines are to be built by the Chantiers de la Loire, but we understand the order has not yet actually been placed.

SEVEN DIESEL MOTORSHIPS FOR U. S. WAR DEPARTMENT

We understand that an order for seven small steel twin-screw motorships has been placed with the Newport Shipbuilding Co., Newport, N. C., by the U. S. War Department for use in connection with the transport service. Two 500 h.p. Winton 4-cycle Diesel engines will be installed in each of these vessels. We may mention here that MOTORSHIP is a publication read with the keenest of interest by the marine division of the U. S. War Department.

MOTORSHIP'S REGISTRY OF MOTORSHIP ENGINEERS

Although shipowners infer that there is a scarcity of experienced engineers for motor vessels, we have frequent applications from engineers who have had positions aboard motorships. Among engineers recently registered with us may be mentioned Mr. T. Archer Pedersen, 172 Carroll St., Brooklyn, N. Y. He is a licensed engineer and has sailed as chief and assistant for about 28 months. His license certificate is for 2,500 tons for chief, and unlimited for assistant engineer. He has also been an erecting and testing machinist with the Skandia Pacific Oil Engine Co., of Oakland, Calif.

REASON FOR BUILDING SOME STEAMSHIPS FOR THE REDERIAKTIEBOLAGET TRANSATLANTIC

In various issues of MOTORSHIP we have referred to the energetic way in which the Rederiaktiebolaget Transatlantic, of Gothenburg, Sweden, have adopted motorships on their various Transatlantic Lines. But, we notice that several steam-driven ships were on order for them in England and endeavored to ascertain the reason from the owners. They advise us that the several steamers which are now building were ordered some considerable time ago. No orders for additional steamships have been placed lately, although contracts have been placed for a number of Diesel-driven motorships.

THE KITCHEN REVERSING PROPELLER IN AMERICA

Arrangements have been made between the Kitchen Reversing Rudder Co., of Liverpool, England, and the McNab Co., of Bridgeport, whereby the latter firm will look after the Kitchen rudder interests in the United States. Among vessels equipped wih the Kitchen reversing-rudder may be mentioned a 100-ton barge propelled by a Bolinder oil-engine.

Another interesting boat recently fitted with Kitchen propellers is an 80-ft. fishing-vessel built on the Scottish coast by the Buckie Slip & Shipyard, Ltd., Buckie. This vessel is propelled by a 76 b. h. p. Vickers-Petters surface-ignition oil-engine.

EXPERT DIESEL-ENGINE OPERATOR'S SERVICES AVAILABLE

Readers of MOTORSHIP will recall the excellent article on the operation of Diesel-engines published in our issues of November and December, 1918, by Mr. Harold B. Wilson, who is in charge of five different makes of Diesel engines in China. Owing to the Diesel-engine plant in question being of too low power for the requirements of the district, the power company are now insalling two 2,500 K. W. steam sets, and intend ordering another 5,000 K. W. steam unit in a year and expect that before many years have passed the station will have reached 20,000 K. W., making a Diesel engine program out of the question for them at the moment.

But, Mr. Wilson, the operator, is not keen on operating steam and would like to be put in touch with shipowners, shipbuilders or engine-builders, who desire the services of an engineer who is thoroughly conversant with Diesel-engine design and operation. We would be very glad to forward any letters to Mr. Wilson sent care Editor of Motorship.

BRITISH MARINE DIESEL ENGINE BUILDERS

Of seventeen leading British merchant-marine Diesel engine builders eleven have adopted the two-cycle type and six the four-cycle.

"ARDITO" AN ITALIAN MOTORSHIP OF 2,400 SHAFT H. P.

Now under construction at the Taranto yards of the Societa Anonima Franco Tosi is a motorship named "Ardito," which will be propelled by twin 6-cylinder Tosi four-cycle type Diesel engines of 1,200 shaft h.p. each. When the vessel is completed, drawings and photographs will be published in these columns.

WORLD'S LARGEST MOTOR-LINER FOR SWEDISH-AMERICAN LINE

It was recently announced by Mr. Dan Brostrom head of the Swedish-American Line that his company are now at work on drawings for a Diesel-driven passenger motor-liner, which will be the largest motorship yet laid-down. This vessel will be built by the Götaverken of Göteborg.

ROYAL NETHERLANDS S.S. COMPANY ORDER WERKSPOOR MOTORSHIP

About a year ago the Koninkijke Nederlandsche Stoomboot-Maatschappy (Royal Netherlands Steamship Co.) of Amsterdam, Holland, subscribed to "Motorship." We have just heard that this well-known Dutch firm has placed an order for a six-cylinder Werkspoor Diesel engine of 1050 i.h.p. to be installed in a new steel motorship of 2200 tons d.w.c.

TURBINE TO DIESEL POWER

Some time ago the Vestlandske Lloyds ordered a 9,000 tons d.w.c. geared-turbine steamship from the Rosenberg shipyard at Tonsberg. When the hull was partially completed they cancelled the order. The hull was purchased by the Bruusgaad & Klosterud Company of Christiania. They decided to change the machinery of the ship and installed two Sulzer Diesel-engines, aggregating 2700 s.h.p. The vessel is now nearly completed.

FOUR MOTORSHIPS NEEDED BY PERUVIAN STEAMSHIP CO.

A cablegram has been received from the American Consulate at Lima, Peru, say the U. S. "Commerce Reports," stating that the Peruvian Steamship Co. desires the names and addresses of American companies interested in building four motorships of the Diesel-type with a capacity of 8,000 tons deadweight and a speed of 11 to 12 knots per hour. Accommodations for carrying 60 passengers first-class are required.

"C. F. LILJEWALCH," THE GRANGESBURG'S FIRST MOTORSHIP LAUNCHED

Launch of the Trafiktiebolaget Grangesburgs Oxelosund's first 8,000 tons d.w.c. ore-carrying motorship has been made at the Götaverken, Göteborg, Sweden, and the vessel which was illustrated in our June issue, has been named "C. E. Liljewalch." She will be operated by the Rederiaktiebolaget Lulea Ofoten of Stockholm, a subsidiary of the Grangesburg Co. Of eighteen sister vessels on order it is expected that all but two will be Diesel-driven.

LAUNCH OF THE WOODEN MOTORSHIP "MURIEL"

The wooden motorship of 3,300 tons named the "Muriel" was recently launched at Lake Washington, Seattle, by the J. H. Price Construction Company. She is a sister ship to the motor-vessel "Donna Lane" which was illustrated and described in a recent issue of "Motorship" and both vessels are propelled by twin 630 I.H.P. McIntosh & Seymour Diesel engines. Each vessel has a lumber carrying capacity of 1,736,596 cu. ft. and has a tanker capacity of 344 tons, or sufficient for a voyage of 69 days at 10 knots speed.

LARGE PASSENGER MOTOR LINER NEARING COMPLETION

"Magvana," the first of the large Diesel-driven passenger-cargo liners for the British India Steam Navigation Co. (See "Motorship" November, 1919) is now nearing the launching stage. She will carry 135 passengers and about 9,250 tons of weight-cargo in addition to fuel, water and stores. She will burn 16 tons of oil-fuel per day with a 13-knot speed. The power is 5,000 I.H.P. and the total machinery space is but 56 ft. long amidships. One of the two sister ships on order has been named "Melma."

WHAT THE "STEAMSHIP" SAYS (JULY, 1920, ISSUE)

"Another serious rival to both forms of screw propulsion (turbine and reciprocating steam-engines) has appeared in the shape of the internal-combustion oil-engine. For a long time this type of engine was thought to be suitable for low powers only, but that—like many other conjectures regarding limit of size of vessels and speed—has proved a fallacy, for since the end of the war vessels propelled by these engines, have advanced from a few hundred tons deadweight up to 8,000 to 16,000 tons, and it is safe to say that the necessary engines will be produced sufficient for any size of ship that may take the water in the future."

WORLD'S LARGEST MOTORSHIP

In our issue of June, 1920 (page 518), we gave some dimensions of the twin-screw British motorship "Glenogle." We are enabled to add to these details. Her leading dimensions are as follows:

Length (O.A.)	502 ft.
Length (B.P.)	485 ft.
Breadth	62 ft., 2 in.
Draught	27 ft., 5 in.
Power	6600 I.H.P.
Number of Cylinders	16
Number of Propellers	2
Bore and Stroke	29 1/10 in by 45 3/10 in.

By the time this appears in print she will be almost ready for her trials.

THE FIVE ARDROSSAN MOTORSHIPS

It is interesting to record that the Ardrossan Dry Dock & Shipbuilding Co. is the only shipyard to have under construction motorships which will have both Werkspoor and Burmeister & Wain Diesel-engines installed. These craft have been previously referred to in our columns.

The two Werkspoor-engined ships are of 7,000 tons d.w.c. and each will have a pair of 1400 I. H. P. Diesel engines built under license by R. & W. Hawthorn, Leslie & Co., Newcastle-on-Tyne, England.

The three Burmeister & Wain engined vessels are of 8,700 tons d.w.c. and the engines will be built at the designers works in Copenhagen, Denmark; altho it is possible that one pair may be built at the Ardrossan plant.

PERFORMANCE OF THE MOTORSHIP "BALCATTA"

The wooden motorship "Balcatta," which is discussed on our editorial page in this issue, is of 3500 tons d.w.c. and is propelled by twin 500 shaft h.p. McIntosh & Seymour Diesel-engines. Until recently this vessel was owned by the Chilberg Line, she has since been purchased by the Pacific Motorship Co. of San Francisco, with whom is connected Mr. Leslie Comyn who built the concrete motorship "Faith." On a recent voyage when in ballast the "Balcatta" sailed from Honolulu to San Francisco in 9 days and 18 hours, altho she encountered a heavy northwester en route. She since loaded 700 tons of cargo at San Francisco, as well as 1,000 tons of general cargo at Tacoma, 400,000 ft. of lumber at Port Blakeley and 600 tons of cargo in San Francisco for Chili and Peru.

PROPOSED CONVERSION OF THE "BOLMEN"

Last year we referred to the proposal of the Rederiaktiebolaget Transatlantic, of Göteborg, to convert their steamship fleet into Diesel driven motor-vessels, commencing with the "Bolmen," and that no definite decision would be made regarding the remaining vessels until the "Bolmen" proved successful in her converted form. An article giving details of the conversion was recently published in another publication. However, we are able to state—on the authority of the owners—that the conversion of the "Bolmen" has not been finally decided because no satisfactory bid has yet been received to carry out the work, pending which we are withholding particulars.

We suggest that American shipbuilders and Diesel engine manufacturers communicate with Mr. F. Madsen, Supt. Engineer of the above company, with a view to securing the work to convert this ship. It should be borne in mind, however, that the money exchange rate is unfavorable for such an order placed in America at the present time.

WHAT A WELL-KNOWN BRITISH SHIPPING NEWSPAPER SAYS

A Warning for American Shipowners

It is apparent that sooner or later the majority of the steamers of the world's Mercantile Marine will be converted to motorships by the installing of internal-combustion engines consuming heavy-oil. On all sides it is now recognized that the motorship, irrespective of the service she may be on can show an enormous saving in running costs over the steamer of same power; she can also make quicker voyages as owing to her great radius of action there is no necessity to put into ports en route to rebunker, while again by the employment of the oil-engine there is a considerable increase in the vessel's carrying-capacity.

This, shipowners in Britain, the Continent and the United States, well realize, for it is clearly evident that the time is coming, and that before very long, when steam-driven freighters will find it difficult to compete with the rapidly increasing numbers of ocean-going Diesel-engined vessels.

While many magnificent motor-driven liners have been built and are building in British yards, little has as yet been done in this country in the way of converting large vessels, the cost of the conversion and the time lost in having the work carried through being the principal deterring factors.

On the Continent, however, it is different. Shipowners there are going solid for the motorship. In Sweden and Denmark there are possibly no steamers of any size being constructed, all of the new craft taking shape being either full-powered boats or auxiliaries, while, moreover, many existing steamers are being converted to single and twin-screw motorships. Oil-engine builders on the Continent are now fully alive to the vast amount of business that lies ahead for them in the converting of the steam-driven Mercantile Marine. —From the Liverpool Journal of Commerce.

BOOK REVIEWS

"Ocean Shipping," by Robert Edwards Annin, published by The Century Press, New York.—In view of the general knowledge regarding ocean shipping and transportation displayed by Mr. Robert Edwards Annin in his book "Ocean Shipping" it is surprising to find that he has entirely ignored reference to the marine Diesel-driven motorship. Yet one chapter is devoted to types of ships and reference to the benefits of the use of oil-fuel under boilers compared with coal, and indicates how under some conditions it is more favorable to use coal. His absence of reference to the economical motorship is all the more remarkable when one reads the following:

"One thing may be taken for granted; that nearly every question of profit and loss in operating a steamer comes back to the fuel-consumption per ton-mile. Her fuel space must be reserved and the room taken by coal is to be deducted from the revenue-paying capacity of the ship."

In the chapter dealing with types of values of the freight steamer, he refers to the limits of economical power and speed of a vessel, quoting that a vessel that requires approximately 30 tons of fuel to drive her at 10 knots will require 52 tons to drive her at 12 knots, and 72 tons to drive her at 14 knots.

Mr. Annin omitted to point out that a motorship of the same size would only require 9 tons for 10 knots, 17 tons for 12 knots and 23 tons for 14 knots. Therefore, we draw Mr. Annin's attention to the fact that the 14-knot motorship is a commercial economic, because for 14 knots she requires less oil-fuel than the 10-knot steamer of the same size.

These matters are important as certain chapters of Mr. Annin's book form a reference guide for shipowners about to place orders for ships.

"The New Merchant Marine" by Edward N. Hurley, published by The Century Press, New York.—The ex-Chairman of the U. S. Shipping Board has produced a very useful book and a chapter dealing with motorships is reproduced on another page of this issue thro the courtesy of the publishers. Mr. Hurley states that he would like to see 200-14 knot 10,000 d.w. ton American ships in operation. He even goes further and asks why build any more cargo steamers, and states that it is his personal belief that some years hence when ocean freight rates come down more than one shipowner will wish he hadn't.

NEW BOOK ON MOTOR BOATS AND BOATS' MOTORS

Shipowners who adopt motor-boating as a pastime, will be interested in a new book compiled and edited by Victor W. Page and A. Clark Leitch, entitled "Motor Boats and Boat Motors," published by the Norman W. Henley Publishing Company, 2 West 45th Street, New York, price $4.00. There is much useful information contained therein. In fact, it is one of the most complete on its subject yet issued, and no doubt it will find ready readers among shipping men who are lovers of motor-boating.

There is a section dealing with heavy-duty motors of the electrical type, also a short section briefly dealing with the Diesel engine. It is a pity that this particular part of the book has not been further extended instead of dealing very briefly with the elementary features of the Diesel design, as the authors have done. For instance, they have unnecessarily included a section of a stationary-type Diesel engine, considering so many drawings are available of sections of marine-type Diesel engines.

Motorships

The Cargo Carriers of the Future

By EDWARD N. HURLEY

[Mr. Edward N. Hurley, ex-Chairman of the U. S. Shipping Board, has written a book entitled "The New Merchant Marine," published by The Century Press, New York, Publishers. Now that he is no longer a Government official, we presume that he feels free to voice his personal opinions regarding the prospects for the success of America's mercantile marine, hence a chapter in his book directed to motorships, and asks "Why build any more steamships?" By kind permission of the Century Co. we are enabled to reproduce this chapter in full.—*Editor.*]

IT has been shown that the use of oil fuel under boilers in an ordinary steam-driven cargo vessel brings about economies that reduce the cost of operation by almost one-third. The use of the same or even cheaper fuel in an internal-combustion engine of the Diesel type will strike off another third of the operating cost. This is why I call the motorship the cargo-carrier of the future. It is practicable to convert any coal-burning ship into an oil-burner, but it is not possible to convert many existing steamships into motorships. For this reason, and as long as ocean freight rates remain high, there may not be much motorship construction during the next few years. Nevertheless, no man engaged in the business of ocean transportation can afford to permit the existence of the motorship to escape his memory for a moment.

The first Diesel patent was granted in Germany in 1893, but it was not until 1897 that the first practical commercial Diesel engine was brought out. It was a one-cylinder affair of only 20-brake horsepower; but its remarkable economy and mechanical efficiency won for it enthusiastic adoption as a stationary prime-mover in shops on shore. The holders of the patents granted licenses liberally, and it was not long before many engine-builders throughout Europe were turning out small Diesel units and improving upon the conception as they went along. The chief difference between the Diesel motor and the internal-combustion engine of familiar every-day use lies in the circumstance that the Diesel burns its fuel instead of exploding vapors from it. Pure air only is compressed, and the fuel is not admitted until compression has taken place. The intense heat of the cylinder at this time insures that the fuel will be consumed as rapidly as it is supplied. For this reason, it is not necessary to use the costly volatile distillates: the Diesel motor will take any oil that can be heated thin enough to be pumped.

Diesels were first used to propel ships by the operators of Russian river steamboats, who fitted them with clutches and gearing to attain reversibility of the propeller. It was in this service that the plentiful supply of cooling water available on board ship, as compared with on shore, revealed the fact that the Diesel would make a better marine engine than it had already been proved as a factory motive power. This experience was the incentive that brought out the reversible marine Diesel, and between 1900 and 1910 a large number of river and harbor steamers of northern Europe were fitted with the new motive power.

The first ocean-going motorship, *Vulcanus*, was brought out in 1910, equipped with a 450-brake horsepower, 4-cycle Diesel built by Werkspoor (Holland). The vessel was propelled by a single screw, and of course attained only a very moderate speed. However, she is still in service in East Indian waters, and has given satisfactory service continuously for ten years.

Close in the wake of this first bold venture came the *Selandia*, engined by Burmeister & Wain (Denmark) in 1911. This vessel is a 7,400 dead-weight ton cargo ship driven by twin screws, each shaft being fitted with an 8-cylinder, 4-cycle, directly reversible marine Diesel motor of 950-brake horsepower. The vessel has been engaged in long voyages between Europe and the Indies in the service of the East Asiatic Company, and her performance has been so highly satisfactory that the several hundred sea-going motorships that have followed her into service have been designed and engined in substantially the same way. There has been a tendency toward larger and fewer cylinders, but almost every other improvement in the marine Diesel has been a matter of mechanical betterment of parts.

In recent years there has been some notable development of the marine Diesel motor in the United States. The highest-powered motorships actually built in this country have been engined by the McIntosh & Seymour Company. Although they have not been equipped with motors of greater horsepower than 500 (two each in twin-screw ships), they have given such excellent service that it is assured American motorship owners will not have to go to Europe for their engines. The McIntosh & Seymour Company has built some 750-horsepower units for the Shipping Board, and the Skandia Pacific Engine Company has built some 850-horsepower units, also for the Shipping Board. The latter company operates under a Werkspoor patent, but the two engines are very much alike in design. Other American builders of motorships are: the New London Ship and Engine Company, which turned out the first marine Diesel produced in the United States; the Dow Pump and Engine Company, which has produced several small ocean-going motorships; and the Winton Company, which has installed a large number of 300-horsepower units in coasting vessels. Several large shipyards, like William Cramp's and the New York Shipbuilding Company, are prepared to undertake the construction of large motorships.

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EDWARD N. HURLEY

Ex-Chairman U. S. Shipping Board

An excellent and very thorough idea of the comparative economies of the steam engine using coal fuel and the Diesel motor using any of its wide range of oil fuels, may be had from the following extracts, taken from the engineers' log-books, of two vessels in the employ of the same company, and engaged in making the same voyage. The two vessels may be described as follows:

While these figures bring out very clearly the fact that the fuel costs of the motorship and the coal-burning steamer compare as 1 to 3, they do not bring out with corresponding force the motorship's advantage in the matter of additional cargo space, or of the smaller number of men in the engineers' force. In a comparison between the somewhat smaller vessel burning coal and oil under boilers in the South American trade, it was shown that 700 extra dead-weight tons of cargo space was worth $21,000 each way. In the European-East Asiatic trade the distance is slightly greater; so that it is probably safe to say that the average difference of 1,000 tons between the cargo capacity of the steamer and of the motorship now under consideration is at least $30,000 each way. Three months' pay for six firemen at $75 a month will add another $1,350 to the credit of the motorship. The total fuel bills of the two vessels compare as follows: steamer, $25,818; motorship, $9,521, for the round voyage. The total net advantage of the motorship, therefore, is about $77,647.

A comparison of the distance traveled, the number of days at sea, and the mean speed show a perceptibly higher average in favor of the motorship. This is the direct result of the superior propulsion obtained from the two small screws of the motorship as compared with the single large screw of the steamer. In anything heavier than a moderate sea, there is always more or less picking up in the speed of the main engine whenever the ship's stern rises, and a corresponding slowing down as the stern falls again and the whole screw becomes deeply immersed. In really heavy weather this irregularity assumes the proportions of "racing," and it is frequently necessary for the engineer to keep the throttle in his hands, shutting off and admitting steam alternately in anticipation of the plunges of the ship. The diameter of the single screw is necessarily so great that it is impossible to center the shaft low enough to prevent racing. With twin screws, however, the immersion is better, and the resultant evenness of propulsion produces a very real advantage in miles cruised in the course of a day. Another

DESCRIPTION OF VESSELS	SINGLE-SCREW STEAMSHIP	TWIN-SCREW MOTOR-SHIP
Length between perpendiculars	385 feet	410 feet
Molded breadth	53 feet	55 feet
Depth	26 feet	30 feet
Cubic capacity (cubic feet)	435,400	501,050
Dead-weight carrying capacity	8,720 tons	9,500 tons
Bunkers (coal for steamer, oil for motor-ship)	770 tons	1,250 tons

ITEMS OF ENGINE PERFORMANCE		
Duration of voyage	163 days	182 days
Time at sea (engines working)	109 days	107 days
Time in port	54 days	74.5 days
Distance run (nautical miles)	27,808	27,818
Hours of steady propulsion	2,574	2,498
Hours manoeuvring	92	82
Mean speed per hour (knots)	11	11.14
Consumption of fuel per hour (pounds)	384	88.5
Consumption of lubricant per 1 horsepower hour (pounds)	0.00045	0.0036
Consumption of fuel for raising steam	49.6 tons	—
Consumption of fuel for banked fires	31.6 tons	—
Consumption of fuel while under full steam pressure, but not moving	7.8 tons	—
Consumption of fuel under steady propulsion	4,415.0 tons	1,062.0 tons
Consumption of fuel while manoeuvring	71.9 tons	14.7 tons
Consumption of fuel for electric light	59.6 tons	19.0 tons
Consumption of fuel for heating	10.7 tons	0.6 tons
Consumption of fuel for winches and pumps	197.6 tons	23.8 tons
Consumption of fuel by main engines	4,544.3 tons	1,076.7 tons
Consumption of fuel by auxiliaries	281.5 tons	43.4 tons
Price of fuel per ton	$5.35	$8.50
Average cargo capacity	7,673 tons	8,670 tons
Number of engineers	3	4
Number of assistant engineers	2	5
Number of oilers	—	4
Number of stokers	14	—
Total engine- and fire-room personnel	19	13
Fuel required to carry 1,000 tons of cargo 1 mile at the speed of 11 knots	50 pounds	10.4 pounds
Cost	$0.12	$0.04

advantage that manifests itself in the same way is absence of the necessity for cleaning fires on board a motorship. Even when cruising in the tropics, the Diesel motor turns over at the same speed hour after hour, day after day, without extra effort on anyone's part at any time or in any circumstances.

A comparison of the fuel consumption figures shows other advantages of the Diesel engine over the steam-engine. On board a motorship there are no banked fires; there is no consumption of fuel for raising steam, or for maintaining full steam pressure while awaiting signals from the bridge. Instead, the fuel consumption starts and stops with the main engine, and there are no "stand-by" losses, even while manœuvring the vessel alongside a dock. The economy of the motorship auxiliaries is especially marked. On board the steamer there are the inefficient winches and the long lines of piping which waste large quantities of heat. On board the motorship the winches and pumps are all motor-driven. In this connection it is interesting to note that a low-power auxiliary Diesel motor shows almost the same fuel economy as the large motor used for propelling the vessel. Furthermore, the Diesel works at relatively high economy under light loads, which circumstance is another factor tending to keep down the fuel consumption of the auxiliaries on board a motorship.

Another important point not brought out by the tabulated figures is the fact that on the voyage in question the steamship coaled ten times, while the motorship took fuel only twice. It would have been possible for the motorship to carry sufficient fuel for the entire voyage, but the experience of the owners has shown that on this particular cruise it is more profitable to purchase in smaller quantities in markets more favorable than the markets of Europe.

One of the noteworthy facts concerning motorships that have come to my attention is the circumstance that the motorship's most ardent advocate is the shipowner who has had experience with one or two of them. There are several European ship operators who declare they will build no more steamers for freight-carrying purposes. In Europe, and recently also in the United States, one sees motorships come and go on regular schedules. The advent of a great smokeless cargo-carrier into a harbor no longer attracts much attention. As time goes on, these vessels are appearing in larger and faster units. Ten thousand deadweight tons and fourteen knots is not an uncommon combination. I should like to see two hundred such vessels cruising under many quarters: "Why build any more cargo-steamers?" It is my personal belief that some years hence, when ocean freight rates come down, more than one shipowner will wish he hadn't.

Marine Diesel-Engine Development in America

Many Important Companies Taking Up Construction

FEW people outside of the marine oil-engine industry have thoroughly grasped the importance of its recent growth in America, many big corporations having lately shown a vigorous interest, some to the extent of having completed plans for construction on a large scale, all going to prove our contention of the past that it will not be long before the oil-engine and motorship industry will rank among the most prosperous and important of the nation's engineering work.

We can divide these companies into three classes, namely:

(1) Firms who have made production of marine Diesel engines.

(2) Firms whose construction plans are almost completed or who have just commenced building.

(3) Firms who are experimenting, developing or making very active investigations with a view to building.

First of all we will list those firms who have actually built marine Diesel-engines, and will give the size of the highest-powered merchant ship engine that they have finished or are constructing, or are about to lay down.

It will be seen from the above that there are twenty well known concerns already deeply involved in constructional work, while there are ten other companies who are hovering-round, and who may come to a definite decision in the very near future. Much depends upon the ambition, courage and progressiveness of American shipowners, who should give every encouragement to responsible firms who already have made an active start in the production of marine Diesel-engines, and promote the construction high-powered and reliable propelling units.

CLASS 1

Name of Firm	Type of Cycle	No of Cylinders	Shaft H.P.	Indicated H.P.	Speed RPM
McIntosh & Seymour	4	6	1,525	2,000	105
Busch–Sulzer Bros., Diesel Engine Co.	2	6	*3,000	4,000	105
New London Ship & Engine Co.	4	6	675	1,000	225
" " " "	4	8	*2,500	3,050	100
Nordberg Mfg. Co.	2	6	3000	4,200	110
Dow Pump & Diesel Engine Co.	4	6	666	885	175
" " " "	4	8	*1,416	1,885	135
Winton Engine Works	4	8	500	625	250
James Craig Engine & Machine Works	4	6	2,250	3,000	105
Worthington Pump & Machinery Corp.	4	6	1,750	2,400	110
Bethlehem Shipbuilding Co.	2	6	2,500	3,500	110
Atlas Imperial Gas Engine Co.	4	6	500	625	175
Skandia Pacific Oil Engine Co.	4	6	850	1,100	135
Western Machinery Corp.	4	4	100	130	—

*Actual Construction not yet started, but plans completed

CLASS 2

The Engines Quoted on the Powers about to Be Laid Down.

Name of Firm	Type of Cycle	No of Cylinders	Shaft H.P.	Indicated H.P.	Speed RPM
New York Shipbuilding Corp.	4	6	1,400	1,940	110
Newport News Shipbuilding & Dry Dock Co.	4	6	1,400	1,940	110
Opposed–Piston Oil Engine Co.	2	4	3,000	4,250	75
Hoovens Owen & Rentschler	4	6	1,600	2,000	100
Moore Shipbuilding Co.	4	6	3,000	4,000	125
†Ingersoll-Rand Co.	4	6	1,700	2,600	125
Manitowoc Shipbuilding Co.	4	6	800	1,100	110
Wm. Cramp & Sons Ship & Engine Co.	4	6	1.650	2,250	115
‡New York Navy Yard	4	10	2,000	3,850	350

†Solid Injection Type
‡Submarine Cruiser Type

CLASS 3

Great Lakes Engineering Works
Fletcher Shipbuilding & Dry Dock Co.
Robbins Dry Dock Co.
Seattle Machine Works
General Electric Co.
Westinghouse Electric Mfg. Co.
Sperry Gyroscope Co.
Pusey & Jones (Hannevig engine now at Hoovens Owen & Rentschler's Works)
Poole Engineering Co.
Federal Shipbuilding Co.
U. S. Steel Corporation

SPANISH ENGINEERING FIRM DESIRES DIESEL ENGINE AGENCY

We note from the U. S. Commerce reports July 7, 1920, that a firm of engineers in Spain wishes to enter into relations with an American builder of Diesel-engines with a view to securing exclusive agency in Spain and Portugal. The registered number of this inquiry is 33,247.

RECENT SAYINGS BY BIG MEN!

"The future of the motorship is exceptionally brilliant."—*Sir Geo. B. Hunter.*

"Scores of ships and scores of voyages have demonstrated the supremacy of the Diesel motorship over steam in economy and practicability for overseas carriage."—*Wm. Denman.*

"The Diesel oil-engine is much more economical than the ordinary method of driving ships. You can't compete with foreign competitors on any other basis."—*Admiral W. S. Benson.*

"I would like to see two hundred American motorships of 10,000 tons and 14 knots speed in service. Shipowners who are building *steam* ships now may soon wish they hadn't."—*Edward N. Hurley.*

"It behooves us to economize in the use of oil in every possible way."—*Professor B. E. Armstrong.*

"The coal-fired boiler and the steam-engine have seen their best days, and in a short time may be on the scrap-heap."—*John Lockie (Editor Steamship).*

"The fuel economy of the motorship makes her cheaper to operate than the steamship in spite of greater investment charges."—*Dr. Chas. E. Lucke.*

"We, in Norway, are convinced of the superiority of the motorship."—*Thor. Thoresen.*

"In a few years every shipbuilding concern in America will be devoting all their activities to building motorships."—*Geo. A. Armes.*

"The economic ship should have Diesel-engines instead of either coal or oil-fired steam-engines."—*Sir J. H. Biles.*

"Oil-fired boiler installations are a terrible waste of fuel."—*Ernst A. Heden.*

"The editorials in 'Motorship' are along the line of my sentiments and I'm glad to see you push the matter so hard."—*Representative G. W. Edmonds.*

"You are in a splendid position to emphasize the advantages of the Diesel-engine to American shipowners in their world-wide shipping competition."—*Arthur M. Harris.*

"I have no reason to doubt the advantages of the motorship. All the evidence is one way."—*Admiral R. E. Coontz.*

"The marine oil-engine is comparable in its importance with the introduction of the steam-engine by Watt."—*Lord Weir.*

"Without doubt there can be profitable utilization of Diesel power in our merchant marine."—*U. S. Senator Arthur Capper.*

"There should be justification shown for the construction of any oil-burning ship which does not use an engine of the Diesel type."—*Ex-Secretary of the Interior Franklin K. Lane.*

"The Diesel motorship is the freight-carrying vessel of the world for economy."—*Frank C. Munson.*

"The necessity for economy is ever more urgent owing to the high cost of coal and oil."—*Alexander Cleghorn.*

"The Diesel engine is far more reaching in its importance than the mere conversion of steam-driven vessel from coal to oil."—*James Hamilton.*

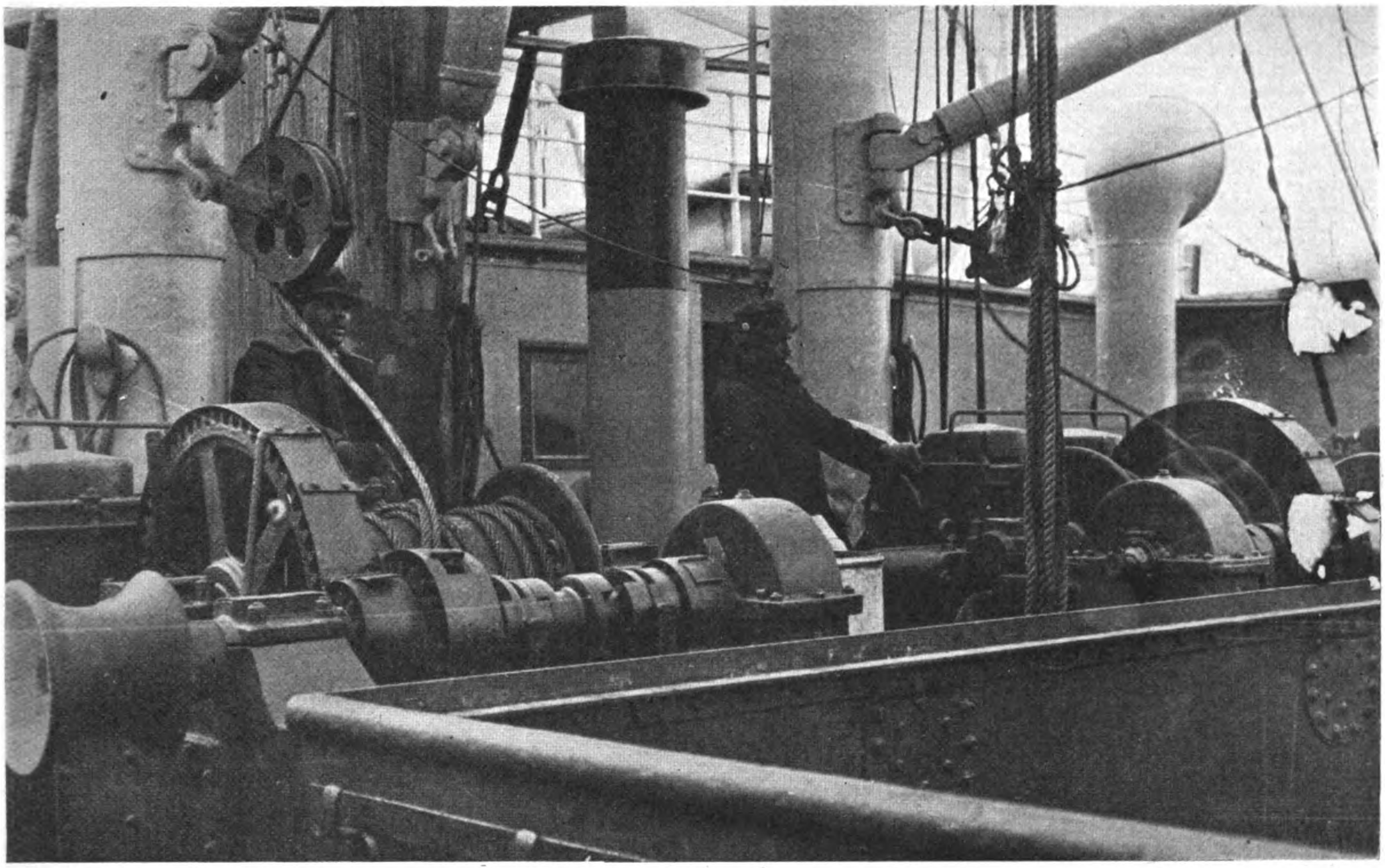
"The Diesel ship is the type of vessel most nearly fulfilling conditions required to produce low transportation costs."—*Geo. J. Baldwin.*

"The future of sea commerce absolutely rests upon the internal-combustion oil-engine."—*The late Admiral Lord Fisher.*

"Lord Fisher was equally right and far-sighted when he predicted that the internal-combustion engine will entirely supersede steam."—*Sir Marcus Samuel.*

"Absolute importance of consumption-economy will lead to a great extension of the use of the internal-combustion oil-engine in maritime practice."—*Admiral Sir Edmond Slade.*

"I am firmly convinced that the internal-combustion oil-engine is the economical power."—*J. H. Rossetter.*

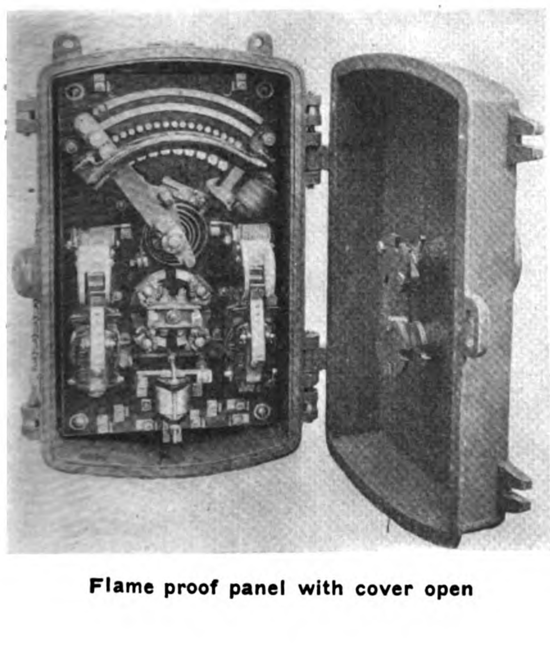


Two electric cargo-winches on a 10,000 tons motorship. This photograph was taken by the Editor of "Motorship" to show the class of unskilled labor that operates the same

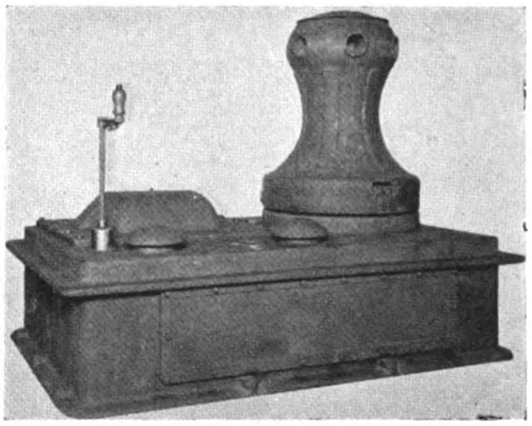
Electrical Equipment Aboard Motorships

Wide Field of Application for Electric Fittings and Machinery—A Useful Technical Discussion of Engine-Room and Deck Diesel-Electric Equipment

STRANGE as it may seem, with very few exceptions, manufacturers of electrical appliances and equipment have not done anything to emphasize to shipowners the great value of electricity aboard modern merchant motorships, mainly for auxiliary machinery operating purposes, also for propulsion. Regardless of this apparent lack of the makers' interest in pushing the value of electrical products when its use is highly desirable, electrical machinery has been very extensively adopted on over one-hundred of the large Diesel-driven motorships now in service on the high seas, and to a moderate extent on over one thousand smaller commercial motor-vessels ranging from sixty to two thousand tons capacity each. In some cases the shipbuilders have had to use strong pressure on the electric-equipment makers before they could be induced to design and supply the special goods needed. A study of our



Flame proof panel with cover open



Electrically-driven motorship anchor windlass built by Markey & Co. of Seattle, Wash.

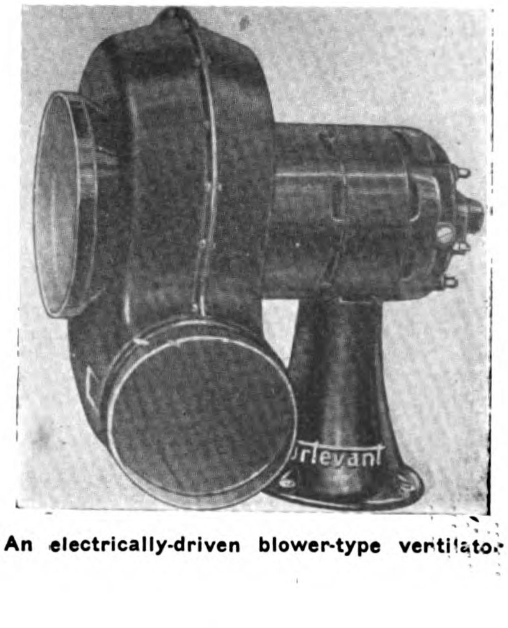
publicity columns will show that only a few electrical firms utilize this excellent medium to educate the shipowner to the uses of electricity.

At the present time there are over 150 ocean-going motorships, ranging from 2,000 to 16,000 tons d.w.c. now under construction in Europe and America, and with half-a-dozen exceptions all the vessels will have "heavy-oil engine-electric" auxiliary machinery installed in the engine-rooms and on deck. On some of these motorships the power for generating electric current runs as high as 1,250 H.P., so complete being the electrical auxiliary machinery. The two new motorships recently ordered by the American-Hawaiian Steamship Co., will each have four (4) Diesel engines of 100 b.h.p. driving electric generators solely for engine-room and deck auxiliaries operation. Much electric equipment will be required on the seven (7) Diesel motorships now building for the U. S. War Department.

Manufacturers of electrical equipment will readily realize that in the merchant and naval motorships industry there is a vast and almost virgin market, which is increasing month by month, so it would be a good business policy to bring their products before the eyes of shipowners and shipbuilders through the section of "Motorship" devoted to publicity.

We may remark here that there is nothing which the average man takes with greater nonchalance than the constantly increasing and varied applications of electricity for either power, heat, or light. He has gradually grown unconsciously dependent upon this form of energy for innumerable comforts, mechanical aids, etc. For marine propulsion, electricity has found many advocates and some opponents; but there are few conversant with marine engineering progress who, while admitting its economy, reliability and general adaptability for auxiliary machinery—especially aboard merchant motorships—will not become skeptical over the question of relative first cost.

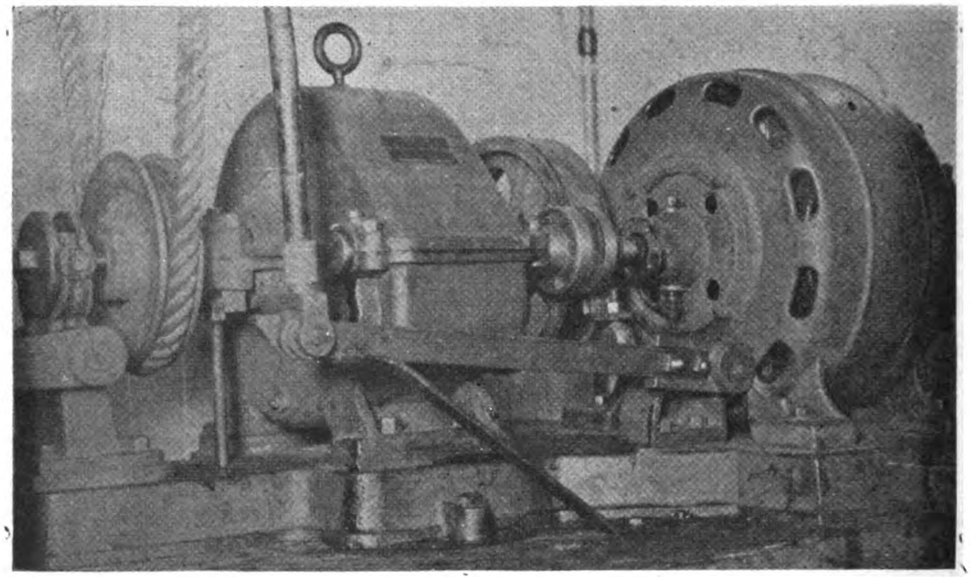
This will often turn the decision against the electric installation by those who consider the



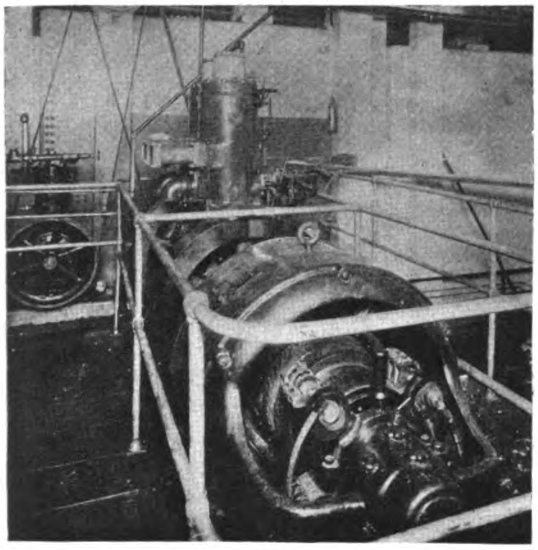
An electrically-driven blower-type ventilator

cost more important than the several main points of advantage that can never be gainsaid. It may be put down as an axiom that the more continuous the operation the more will the inherent advantages of electric-power be made manifest and the economy of operation will quickly outweigh the increased first cost. At present the adoption of electrical machinery for marine use both for main propulsion and auxiliaries has the support of nearly every engineer who has been fortunate enough to be shipmates with the system, and on no vessel is its use to be more advised than the motorship as plenty of current but no steam is available. Diesel-electric drive is particularly adapted to furnishing propelling-power in the case of existing steamers converted to the motor system, as the existing propellers and shafting can be used, but is outside the scope of this article.

There is a fundamental difference between the operation of electrical and other power plants, and it may be briefly summed up as follows. As ordinarily understood there is no working medium under pressure as with steam, air, or water, practically no heat, little or no noise and usually the elimination of all reciprocating mechanisms and hence vibration. There is of course the so called electrical pressure or potential, but the conductors of this pressure are more efficient, permanent, and flexible than the old piping systems. Progress in the development in this field has been rapid and indicates an interesting future.



Herzog electric steering-gear of the motorship "S. I. Allard"



Surface-ignition oil-engine driven generator installed in an American motor schooner

The adoption of the Diesel, solid-injection, and surface-ignition types of oil-engines for marine use opens a vast field for the electrical auxiliary that promises a new era for the sea-going engineer. Already it is being used on the majority of motorships now in service, as we have just remarked.

With long lines of steam and exhaust piping dispensed with, and their attendant troubles due to expansion, freezing, water-hammer, leaks, and radiation losses being eliminated, the suitability of electrical deck-machinery can be understood. Its economy is unattainable by the steam installations and such machinery is establishing very good performance records as regards repairs economy, ease of operation by unskilled labor, and ability to withstand abuse and a certain amount of neglect. The three latter features are very essential to any deck-machinery of the average cargo tramp.

Furthermore, in cases where steam-propelled vessels are to have electrical auxiliaries it probably pays to use the Diesel-electric system form of auxiliary machinery instead of steam-electric. This offers a new field which shipowners and shipbuilders should study even if the main engines are steam operated.

Practically the same results in control and overload capacity may be obtained with electric as with steam-driven units. When proper installations are made, and everything enclosed watertight and locked, a great increase in fool-proofness is obtained.

The nature of the service to which electrical apparatus is adaptable on board ship is such that special requirements as to construction and performance must be specified. Let it be strongly emphasized that marine service does require special design and construction for electrical equipment. Disappointments and failures will crowd one upon the other, if the necessary precautions as demanded by hard use, exposure to corrosive atmosphere and possible neglect are not taken. Practically all equipment is exposed to the salt air and much of it located where the iron parts may sweat or the contacts and the insulation be constantly moist and even immersed in water.

Requirements for all deck-machinery, etc., should be watertight and non-corrosive construction. The connections, cables, and contactor panels should be thoroughly insulated and enclosed both for reliability and safety. Varying locations of installations will call for attachment to floors, bulkheads or suspension from beams overhead. All leads should be run in armored lead-covered cable or standard pipe, and all connection outlets and fuse-boxes fitted with watertight entrances.

All enclosed motor frames or contactor panels should be provided with drain plugs at accessible points, and with watertight handhole plates to give easy access to brushes, commutator and field coils. A standard test for water tightness is to direct a stream of water under 15 lbs. pressure from a distance of 10 feet. The test of motors should embrace most if not all the following points.

(A) Adjustment and fit of parts.

(B) Mechanical strength and physical qualities of parts.

(C) Balance of armature. Motor not to have objectionable vibration at 50 to 100% normal speed.

(D) There should not be excessive noise.

(E) Sparking of commutator. Load should be varied from 0 to ¼ overload without excessive sparking.

(F) Variation of speed under loads. (In shunt wound motors from full to no load:)
12% in motors under 5 H.P.
9% in motors over 5 H.P.

(G) Dielectric strength of insulation.

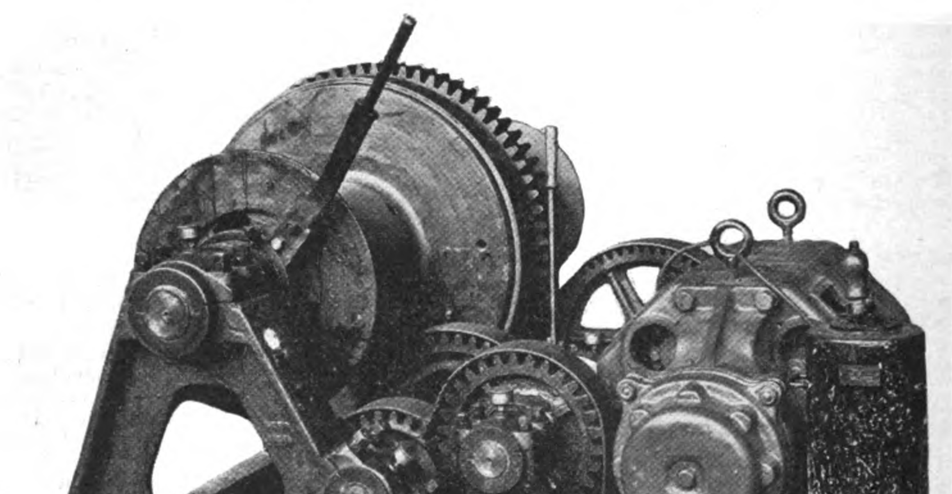
All electrical machinery must be designed for ample overloads, as in this way the heat losses and stresses will be minimized. It must be remembered that the deck machinery when exposed for days to the heat of the sun in the tropics will become very hot and this temperature must be well below the upper limit allowed for in normal operation. It is seldom that any facilities are near at hand for repairing modern machinery in such parts of the world.

A table of allowable temperature rises in degrees Centrigrade under full-load test follows. It must be remembered that machinery which is liable to continued abuse from rough and unskilled labor and exposed to the heat of the tropics should fall well within these limits.

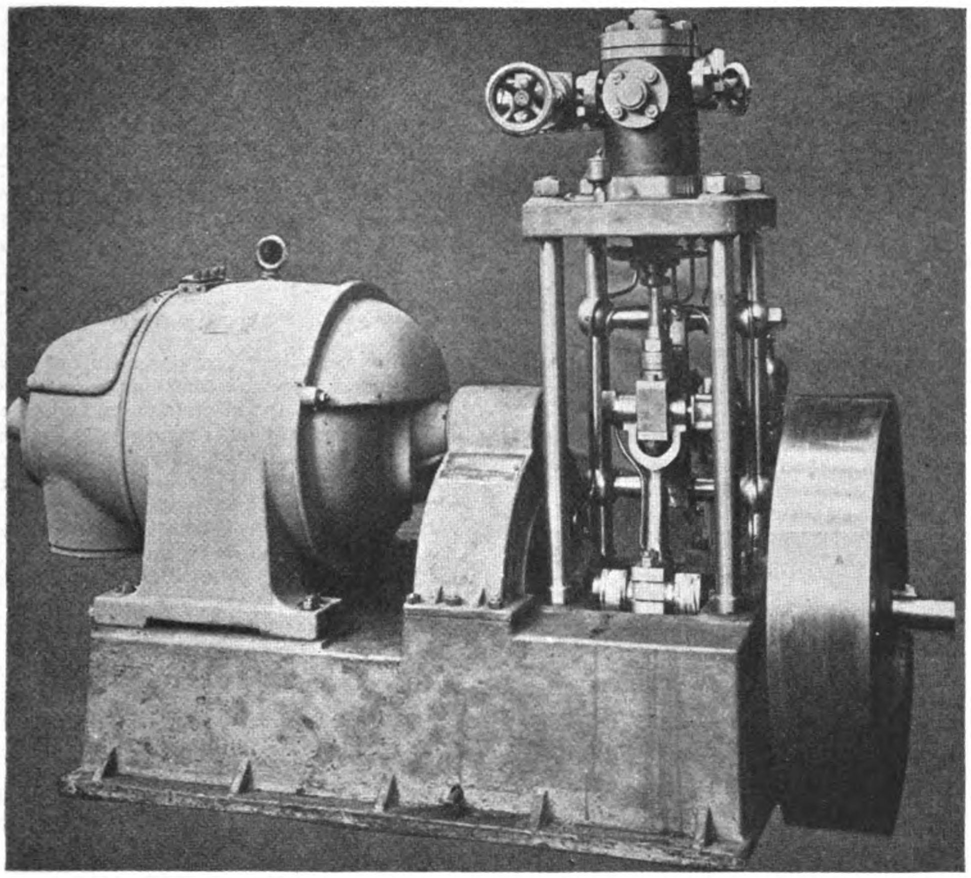
Part	Duty					
Type	Continuous (2 hours or more)			Intermittent (1 hour or less)		
	Open	Semi Encl.	Encl.	Open	Semi Encl.	Encl.
Core and Windings	40	45	50	50	55	60
Commutator	45	50	55	55	60	65
Bearings	35	35	40	35	35	40

When windings are protected by non-combustible waterproof insulations, the allowable rise in temperature may be increased to 75° C. The length of the heating tests should be in proportion to the nature of the service conditions.

In the case of a tankship carrying very light oil-cargo such as gasoline, all the electric motors in the pump-room must be absolutely air-tight, and ventilation must be carried from and to the atmosphere through a system of pipes and blow-



Electric-winch built by American Engineering Co. of Philadelphia, Pa. It operates at a speed of 150-200 ft. per minute



Electric-motor driven air-compressor for motorship's refrigerating-set built by Thos. Sabroe of Aarhus, Denmark

ers thus avoiding all danger of explosion from sparking.

Controllers

Controlling appliances are designed for two kinds of currents, alternating and direct, and, of course, vary with the service and power to be controlled. These devices include ordinary knife switches, dial and contractor controllers overload and no voltage releases, resistances, safety devices, etc.

Controllers may in general be of the panel-type, drum-type or relay operated contactor type, and when installed in locations exposed to the weather or in wet places, or liable to mechanical injury and in spaces likely to contain oil fumes, etc., they should be totally enclosed and perfectly watertight. If required to be watertight they should be tested by complete immersion, which should not interfere with proper operation. In any case, all controlling devices, whether watertight or not, should be protected by a rigid, strong metallic casing, in which are fitted convenient access doors. The interior of these casings should be lined with asbestos or other suitable dielectric and fireproof material, in way of contacts or switch poles at which arcing may occur or where short circuits may develop from carrying an overload.

Panel type controllers are suitable for starting and regulating continuous running motors of less than 10 h.p. But, above that power, the controllers should be of the drum or contactor type. Drum type controllers are best suited for circuits where the motors require frequent starting, stopping and changing speed. Contactors or solenoid switches will be used where "distance control" is required or where the duty or location is such as to cause rapid deterioration of controller contacts. Small motors requiring less than 10 amperes of current, which can be safely started by throwing the armature directly on the line without previous acceleration, need only be fitted with a knife switch and fuses for control.

All controlling appliances should operate under service conditions without showing a rise in temperature exceeding 40° C. in any part except resistances and current coils of the solenoids in contactors and circuit breakers upon which a rise in temperature of 50° C. should be considered safe. All appliances should be accompanied by a diagram of electrical connections, with each terminal designated to correspond to the working of the appliance itself.

Panel type controllers when designed to be watertight and flame proof should be made of a rugged metal casing about 1/16 in. thick in which should be assembled all the necessary fittings, resistances, etc. Suitable bosses for tapping for conduits into the casing should be provided and located so as to simplify the leads within the casing. The panel is to be operated from without by means of cranks turning in composition stuffing tubes in the casing.

Rheostats

Material used for the resistances in rheostats must be non-combustible at operating temperatures at least and non-corrodible in salt air or water or by heating to a low red heat. The class of duty required should be allowed for in proportioning the resistances, as trouble may arise on using a rheostat intended for intermittent currents continuously, as in the field resistances of motors. Rheostats carrying continuous current should not exceed a rise in temperature of 175° C. by a thermometer when carrying their rated current.

Resistances when starting must be capable of carrying, when cold, 50 per cent overload for one minute and 100 per cent overload for 20 seconds without damage.

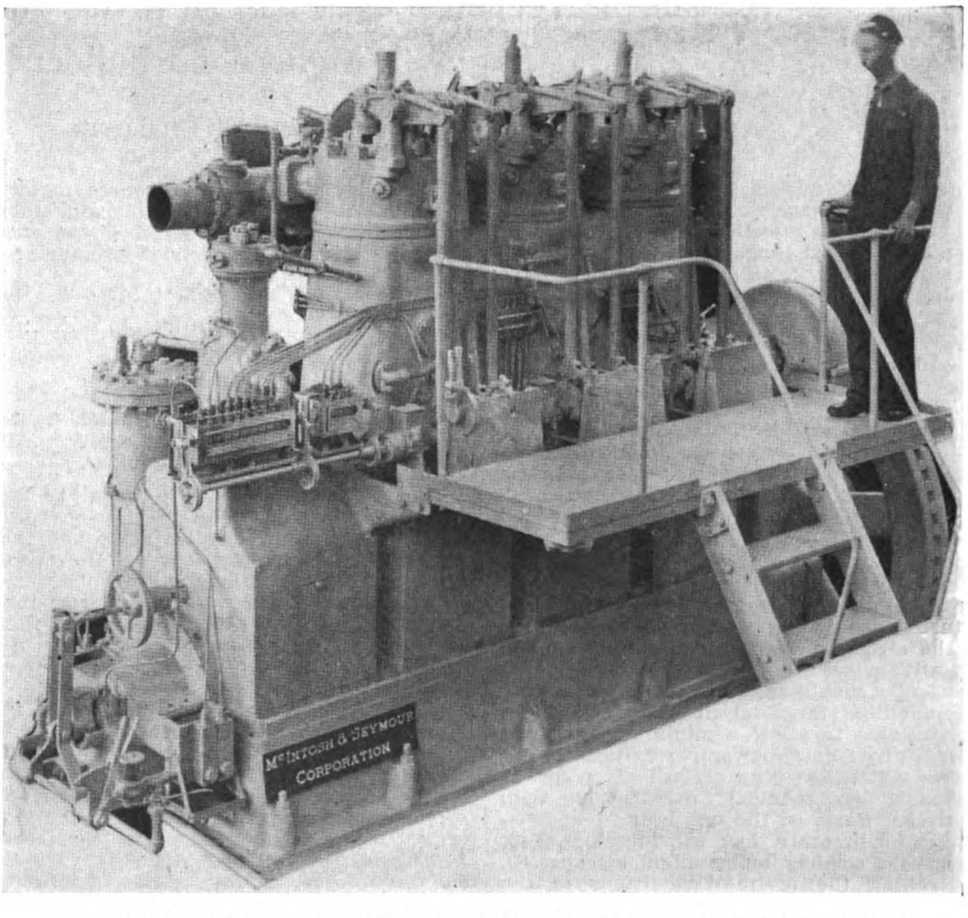
It is the purpose of this short discussion to illustrate a few applications and mention the results to be expected from them.

Take, for instance, the electric steering-gear installed on the auxiliary motorship "S. I. Allard." Relay controllers fitted with a selective dial are provided at all steering stations throughout the ship, and by means of the relay circuit the contactor controller installed near the steering-gear motor handles the main armature current. This system of remote control obviates the danger and expense of handling the heavy armature current in a circuit running all over the ship. The motor starts and stops quickly and maintains practically a constant speed of helm.

Perhaps one feature that is not clear to many people is the fact that an electric gear may be simplified by eliminating the follow-up control. In that case there are only three positions of the steering control-lever, namely, one port, starboard, and amidships (or neutral). When the relay control is turned to either port or starboard the motor starts and continues to swing the rudder until the control handle is returned to amidships. There is, of course, a helm indicator mounted on the steering starboard, which gives the helmsman actual knowledge of the amount of helm carried at all times.

Other electric steering-gears operate on the follow-up system similar to a steam-gear, in which case the circuit is broken and the steering-gear motor stops after the desired amount of helm has been reached without returning the control handle to amidships. A very neat application of electricity for steering is developed in the electric-hydraulic gears. These are very positive in action and rugged, yet sensitive to small helm angles, are economical in operation and may be arranged in various ways, so are very economical as to space required.

There are many electrical fittings and units for various services of which most have been perfected for land use, and, with proper attention to the insulations and contacts, may be adapted for marine use, particularly aboard motorships, where plenty of electric current is usually available. Among the applications already in use are electric-driven forced-draft blowers, ventilating-fans, ballast-pumps, oil and water circulating-pumps, pyrometers, telephones, tortion-meters, submarine signalling, logs, syren, machine-shop tools, deck-machinery, wireless, engine-telegraphs, storage-batteries, cargo-pumps, refrigerators, lighting, ranges and other galley apparatus, etc., and even devices whereby the propelling Diesel-engine can be controlled by the navigator on the bridge.



An auxiliary Diesel engine for ships' dynamo driving built by McIntosh & Seymour

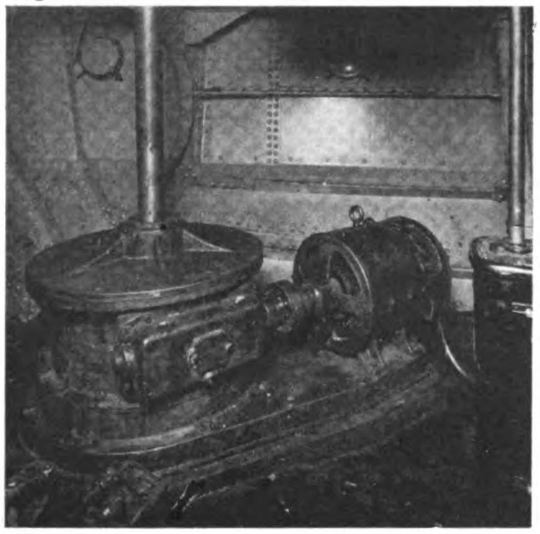
One of the illustrations accompanying this article shows a typical type of American Diesel engine used for driving generating sets aboard ship.

A refinement not ordinarily fitted to slow-running engines of cargo vessels or any merchant ships is the electric tachometer. This device will show the revolutions per minute of both engines (port and starboard), in the engine-room and on the bridge. The principle of this apparatus is the same as that of the automobile speedometer. A feature of the tachometer is that it visualizes immediately a change in either or both speed and direction of revolution.

Perhaps most important of the deck auxiliaries are the electrically-driven cargo winches. These have been, and still are, usually direct-current machines with the field in series with the armature, except with just enough shunt-winding to prevent excessive speeds under no load. This feature provides large starting torque under heavy loads and an increasing speed with lighter loads. However, the average speed with varying loads with a winding of this nature is far below that which can be obtained with the old steam winch.

A British concern with long experience in marine electrical machinery has developed an automatic contactor control, which operates to increase the speed of the motor when handling less than full loads. This device consists essentially of a solenoid-operated shunt-circuit in the series winding of the field. During starting-up and at normal low speeds when the counter e.m.f. in the armature is low, and hence the imposed e.m.f. from the power mains is high, the current carried in the field windings is heavy. As the motor speeds-up under light loads and the field current decreases, the shunt resistance is put into the circuit, and thus the motor can speed up beyond what would be the normal speed of a straight series wound motor. This "load discriminator" can, of course, operate at any position of the master controller, as it is in series with the starting resistances. This feature will also operate in a reverse manner to prevent an overload as follows: If the diverter resistance is in shunt with the field windings and the motor is overloaded so that it slows down too much, the current through the armature increases until it is strong enough to operate the solenoid and cut out the shunt circuit. This increases the field strength and the torque.

Hyde electric capstan of American motorship "Solitaire"



Showing Diehl electric motor operating capstan illustrated above

Many very successful and rugged designs of electrical deck-machinery have been built and are available. Those interesting themselves in the motorship, as all should who give the proper consideration to economy, should not neglect to investigate the really great economy obtainable with electrical auxiliaries for deck use.

Steering Gear

For the very heavy service required of a steering-engine and the constant starting and reversals to be performed, the electric motor, when properly designed, has proven exceptionally satisfactory. The U. S. Navy was probably the first to use electric steering-gear in this country, and the arrangements furnished them by the contractors were a gratifying success from the start. Originally the usual follow-up feature was incorporated in the gear, but the great simplification and ruggedness obtainable with an ordinary controller and helm indicator led to the adoption of the present system. The steering standard now only contains a controller relay and a helm indicator. The helmsman in this case merely throws the control-handle to port or starboard, and when the helm indicator shows the required angle or rudder he stops the steering-motor by moving the handle to the neutral or mid-position. To steady the swing of the ship the control-handle is moved to the other side, while the indicator at all times shows the amount of helm. The master controller is placed near the steering-gear motor, and relay control-stations may be placed as desired in various parts of the ship. The connection between the motor and the tiller may be either hydraulic spur-gearing or the usual worm-screw.

Lastly we may refer to the intentions of the U. S. Shipping Board and of several owners and shipbuilders to further use the Diesel-electric drive for motorship propulsion, but that is another story, worthy of a special article.

Air-Injection for High-Pressure Oil-Engines

A Valuable Technical Article of Particular Interest to Diesel Marine-Engine Designers and Builders (Part II)

By J. L. CHALONER

(*Continued from page 632, July issue*)

The foregoing instance would help to justify the impression that air-injection as an atomizer proves satisfactory only within well-defined limits.

(2). *Compressed air as an atomizer.*

In dealing with the properties of compressed-air as an atomizer, the question arises immediately as to whether the primary function of the air is:

a the atomization of the fuel on passing from the fuel-valve into the cylinder,

or

b the creation of the required degree of turbulence in the cylinder, in order to bring the whole of the available combustion-air in close contact with the fuel charge.

Data will be given later for some general conclusions to be drawn on this point.

For the time being it is obviously the chief consideration to determine the minimum amount of air required to give the desired degree of atomization or turbulence whatever the case may be. The smaller the air-pump, the higher the mechanical efficiency with a resultant fuel economy. On the other hand, if a maximum amount of compressed-air can be admitted, then that air-excess co-efficient may be available to allow a minimum bore and stroke for a given horse-power per cylinder. The compromise which has been arrived at so far, is less the result of technical investigations than those untiring efforts on the test beds.

The injection-pressure has considerable effect on the degree of combustion, as might be expected, thus controlling the thermal conditions of the engine generally. The combustion-chamber temperature depends on the injection-pressure, having due regard, of course, to the compression pressure, without being influenced materially by the fuel consumption. The following table gives temperatures of the top of the piston under various injection and compression pressures:

TABLE No. 2

Engine: 39 B.H.P.; Bore: 11.8 in.; Stroke: 1775 in.; r.p.m. 190

Injection pressure lbs. sq. in.	Compression pressure lbs. sq. in.	Fuel-Consumption lbs. per B.H.P. hour	Mean-effective pressure lbs. sq. in.	Piston-top temperature
715	285	0.522	110	625 F.
830	400	0.481	110	660 F.
1180	575	variable—0.480	...	......
....	...	" —0.490	110	870 F.

The pressure difference between the final compression-pressure and the injection-pressure in the first and second trial is the same and the piston temperature varies very little. However, in the third test there was a pressure difference of 605 lbs. per square inch, which gave rise for an appreciable increase of temperature for the piston, although the fuel-consumption has been decreased by something like 8 per cent between the first and third trial.

It is, of course, well known that the injection-pressure bears a most direct relation to the load in most types of modern high-pressure oil engines. The degree of combustion depends very largely on the correct injection-pressure and also on the scavenging-pressure in the case of the two-stroke cycle. If for instance, the conditions are taken, which exist at full load, then by varying either one or the other of the variable factors, the effect on the load and the exhaust temperature can be noticed. In Fig. 17 the injection-pressure is varied, and its effect on the load, the temperature and color of the exhaust can be noted. In Fig. 18 the scavenging-air pressure is reduced, whilst keeping the injection-pressure constant, whereas in Fig. 19, the fuel supply is increased without adjusting either the injection or scavenging air-pressure to meet the increased load.

The fact that the injection has to be changed to suit corresponding loads, has given rise to the question, what variation of load is possible without having to alter the air-blast accordingly. Experience has shown that loads varying between ⅝ and ⅞ of the full-load, are least sensitive to fluctuating blast-pressures. The result is that under favorable conditions the injection pressure may remain constant for loads varying from 0.60 to 0.93 full-load. There are, of course, certain devices available, by means of which the injection pressure is varied automatically to suit the load, but so far they have not been supplied successfully to marine oil-engines.

It is now intended to examine the relation between the weight of fuel and compressed-air with a view to determine any laws connecting these two factors.

It is hardly appropriate here to discuss the methods of measuring oil and air. It is a matter

more for the test engineer in the erecting-shop of the manufacturer rather than the engineer on his watch. However, let it not be understood that the field of research is closed to the sea-going engineer. It is suggested that in a simple way, considerable assistance could be given by observations made during the voyage apart from the ordinary data, required for the filling-up of the log-sheet.

The leading dimensions of the engine on which the above tests were carried out are as follows:

Engine		Compressor	
Diameter	8.5 in.	L. P.	4.6 in.
		H. P.	3.5 in.
Stroke	13.4 in.		4.0 in.
Compression Ratio	11.58		

at 250 revolutions per minute. The diameter of the cylinder was 12 inches, the stroke 18.25 inches and the compression ratio 15.3.

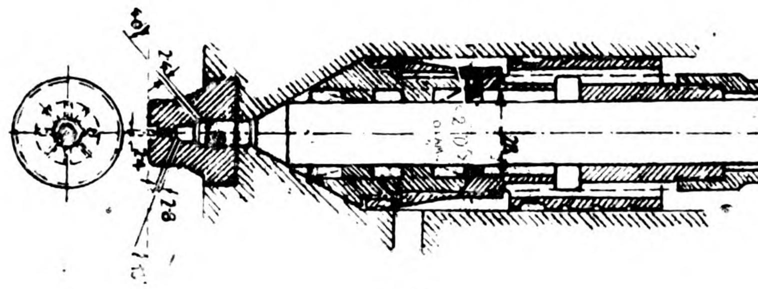


Fig. 6

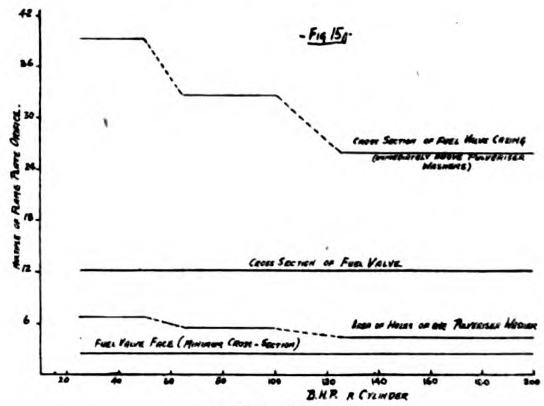


Fig. 15a

The control of the oil supply and the exact measuring over definite periods is comparatively simple. The determination of the total volume of air fed into the engine, either through the suction boxes or the air-pumps, is somewhat more complicated or perhaps more troublesome. Let it suffice here to state that air can be measured by three methods:

1. By means of an air meter.
2. By using a reservoir of known capacity for supplying the compressed-air, and noting the drop of pressure over a definite period.
3. By filling the starting-bottle by means of the excess air from the air-compressor, after supplying the engine.
   The essential conditions for this method are
   a. Constant speed of engine.
   b. Air-compressor suction-throttle fully open.
   c. Volumetric efficiency of compressor must be known as a function of the compression-pressure.

The second method is one which appeals most readily to the marine engineer. The storage

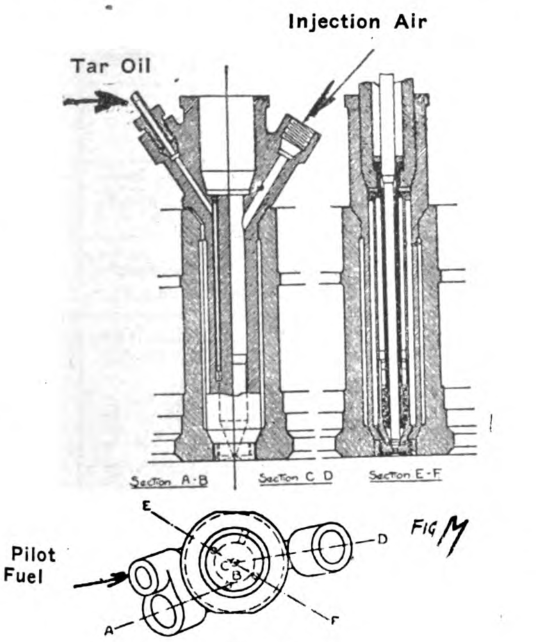


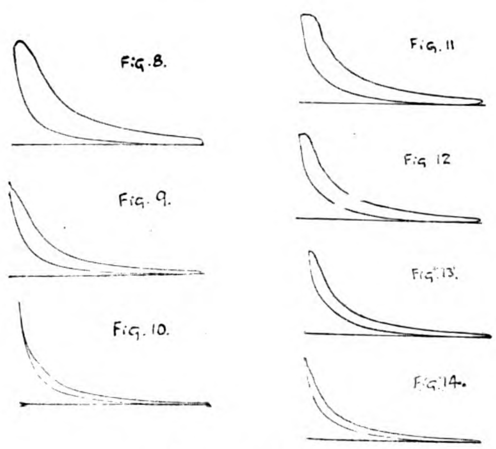
Fig. 7

capacity of the compressed-air reservoir on board of ship is readily obtainable from drawings supplied by the manufacturers, and there is certainly a most excellent opportunity for contributing valuable information to the chapter of heavy-oil engine construction.

We shall now turn to some actual results obtained, and in Table No. 3, are given some data obtained with a 15 BHP, by keeping the load constant and varying the blast over a very wide range. The engine works on the ordinary four-stroke cycle, and the test was carried out at 0.85 full load.

In connection with these tests it was pleasing to note that a record of the chemical and some of the physical properties of the fuel had been kept. Everybody admits that the fullest benefit from any experiments can only be obtained, by taking a note of all possible data, and information of the grade of fuel used during the tests is of considerable importance. Yet most experimenters lose sight of this fact, or else if they don't, they do not seem to consider it of sufficient moment, to publish them together with the results of the mechanical observations.

The oil used was a gas-oil of German origin; the following data were determined:



Figs. 8 to 14

1. Chemical Analysis

Carbon	85.30%
Hydrogen	11.60%
Sulphur	2.35%
Oxygen	0.65%
Ash	0.10%
Water	Traces

2. Physical Analysis

Calorific Value	17800 B.Th.Uts.
Specific Gravity	0.885

The experiments were carried out by Munzinger,* and there is no doubt that his research will be looked upon as a classical contribution to the study of the heavy-oil engine.

In Fig. 20 are reproduced some curves and indicator diagrams, as determined during these investigations, and should be examined in conjunction with the figures given in Table No. 3.

As might be expected, the fuel-consumption increases with a decreasing injection-pressure, rather gradually between pressures of 930 lbs. and 750 lbs., and quite appreciably below that pressure. The exhaust temperature follows the fuel-consumption very closely, and forms a rather good indication of the most favorable injection pressure.

The engine on which these tests were carried out, was of rather small horse-power, and for comparative purposes another series of tests are given. The engine in this case was a four-stroke single-cylinder vertical engine developing 50 BHP

*Munzinger, Forschungsarbeit Heft 174.

The injection-air was measured according to the second of the three methods enumerated above, and experiments were carried out at 41 per cent and 94 per cent full load. The power absorbed by the air-pump was determined during one experiment under conditions as follows:

The air-compressor was cut out, the injection-air being obtained from the storage reservoir, and the injection was kept constant at 800 lbs. per square inch. In Fig. 21 a flashlight diagram is taken when the air-pump is not supplying any air to the fuel-valve casing. In Fig. 22 the injection-air is supplied in the usual manner by

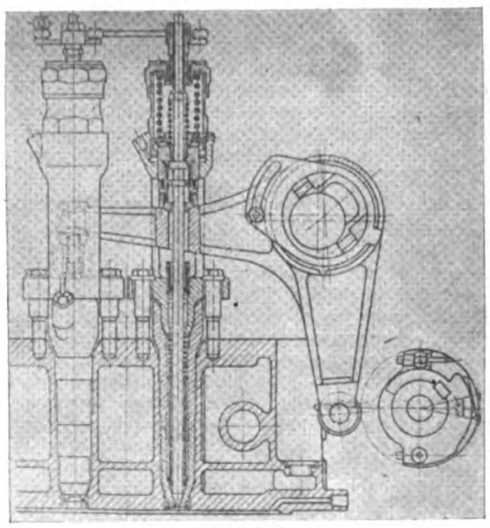


Fig. 16

the air-pump. The horse-power taken by the air compressor is the difference between the indicated horse-power recorded by the two tests, and amounts to 8.8 H.P., when air is supplied at 800 lbs. per square inch.

In tables No. 4 and 5 are recorded the effect of varying the injection pressures for approximately half and full load.

(Continued in our September issue)

TABLE No. 3

Horse-power	12.68	12.66	12.63	12.68	12.60	B.H.P.
Injection-pressure	930	858	785	715	643	Lbs. p. sq. in.
Cycle-air	0.0093	0.0093	0.00933	0.00932	0.00932	Lbs. p. cycle
Injection-air	0.00173	0.00156	0.00128	0.00102	0.000771	do
Fuel-Oil used	0.00088	0.000895	0.000900	0.00092	0.001015	do
Excess Air Co-efficient	2.39	2.32	2.29	2.29	2.02	
Exhaust Temp.	634	655	672	702	792	Degrees F.
Speed	236.2	236.0	235.8	236.2	235.0	Revs.p. min.

FROM BRITISH TO DANISH OWNERSHIP

We hear that the big 14-knot British motorship "Glenapp" has been transferred to the East Asiatic Line, with which Lord Pirie is also connected.

SEATTLE MACHINE WORKS DIESEL ENGINE

Excellent results are being obtained from the experimental tests of the single-cylinder Diesel engine at the Seattle Machine Works, Seattle, Wash., and a six-cylinder 200 h.p. engine is now being planned.

MOTORSHIP "TOSCA" LAUNCHED

The new 6500 ton motorship "Tosca" built in Holland for Winge & Company of Kristiania, was launched on May 17th at the Netherlands Shipbuilding Company, Amsterdam. Twin 1400 I.H.P. Werkspoor Diesel-engines are installed. Captain Bugge, of Winge & Co., was recently in New York and spoke in glowing terms about motorships. The Norwegian-Russian Line has arranged with Winge & Co for regular sailings of four Werkspoor engined motorships to the Black Sea and Levant.

FROM TURBINE TO DIESEL

Hitherto the Gylfe Steamship Co., of Copenhagen, Denmark, have operated steam-turbine driven merchant-vessels. In our June issue we referred to motorships being on order for them. These are two 6000-tons d.w.c. vessels, and both will have twin 1500 I.H.P. Burmeister & Wain Diesel-engines installed.

The Steinbecker Solid-Injection Engine

A New Design of Constant-Pressure Oil Motor, Built by the German Automobile Construction Company, Ltd., Berlin, and The Hanover Machine Co.

(Translated by W. Roylands Cooper.)

(PART II.)

(Continued from page 626, July issue)

It further lies in the nature of the process that the fuel during the whole time of mixing being projected through the lower part of the chamber, enters this part in excess, this excess being partly in liquid form, because the particles last ejected have not time to become vaporized. When the reversing movement takes place in the ignition chamber, these particles are thrown against the walls.

It follows, therefore, that the lower part of the chamber in particular must be kept above the critical temperature so that these small particles are immediately caught up and transformed into vapor. The correct arrangement of the temperature of the wall is, from a constructive point of view, very simply obtained. The ignition-chamber, from the point where it joins the connecting passage, is supported freely in space and the middle portion provided with thin ribs.

Cooling of the chamber is brought about by drawing a portion of the air charge over these ribs, the cylinder-cover wall being provided with a small passage connecting with the air-valve. Heat flow in the walls of the ignition-chamber is regulated by the correct number of ribs, and is so constructed that the minimum temperature is reached and the highest admissible temperature is not exceeded; for this reason the upper portion of the chamber, having in view the ignition point, is kept hotter.

If these proportions are once rightly determined, no further regulation of any kind is needed during the working of the engine.

Assuming the temperature of the walls is fixed another factor enters, namely, the heat in the air which is made up of the heat due to compression and the heat transmitted through the walls. This heat has a very important influence on the process going on in the ignition chamber, especially on the ignition point. The charge reaches the ignition-chamber through the connecting passage, which is also the passage through which pass the hot gases at flame temperature. In order that unduly high temperatures of the air charge may be avoided, which might lead to pre-ignition and faulty mixing of the fuel and gases, also to insufficient compression, this connecting passage must be cooled.

With good cooling the temperatures may always be kept within suitable limits and the necessary non-sensitiveness to change of temperature maintained. How this problem is solved constructively will be shown by the drawings. The main cooling-water of the engine is first led round this connecting passage and from this point is further conducted to the cylinder and liner jackets.

It will also be seen that controlled temperatures are of fundamental importance for the proper governing of the ignition chamber reactions.

(4). *Tests on the Steinbecker Engine Carried Out by the Government Marine Office (Reichs-marine-amt).*

The test engine, built by Hanomag, Hannover-Linden, was placed under test during the period from 31st January, 1917 to 3rd February, 1917, by the Reichs-marine-amt, with which test the following report deals:

The Secretary of State
of the Reichs-marine-amt,
Berlin, 7th February, 1917,
Re the Steinbecker Engine.

"Further to my letter K II d 1777 of the 29th January, 1917, I have pleasure in informing the Hanover Machine Co., Ltd., formerly Georg Egerstorff, that the test of the Steinbecker Engine without air-compressor has given satisfactory results. The engine ran for 72 hours without stopping and without the sooting-up of the ignition-passage and ignition-chamber. Only towards the end of the test were one or two miss-fires noted, which could be traced back to the fuel-pump valves and leaky stuffing-boxes, and not to the ignition-chamber."

The question of starting is already dealt with in the report and nothing further need be said regarding this. In any case, the engine has now reached such a state of perfection as to justify its adoption.

It would be necessary to improve the engine in two directions. Firstly, the reason for the dispersion of the diagrams must be found and the cause eliminated—the remarks on this matter in the report are not at all adequate;—secondly, endeavors must be made to do away with the warming of the ignition chamber at starting.

These questions will be carefully gone into before the engine is put on the market, as experience shows that such little troubles tend to increase with the manufacture of engines in number. With further and more complete tests questions will be finally solved, and a step taken whereby the process may eventually be modified to a medium pressure process.

By the application of a new device, which we will refer to later, a new working-cycle will be introduced in the Steinbecker engine so that with lower compression-pressures a rise in pressure will be brought about, which has been proved to be very nearly ideal from the thermal point of view, the pressure-line being completely controlled by the cam form. This will combine the advantages of both the Diesel and the Otto cycles.

General Remarks and Comparisons

This working-cycle is achieved by the simplest means, the only working parts being the pumps, which are of reliable and simple design, all other parts being such as can be incorporated in a well designed cylinder cover. The design and construction of the engine *from the point of simplicity is comparable with the steam-engine.* The light and elaborate parts are made as far as possible in repetition form, and may be manufactured in groups for several types, which will allow of cheap production. The reliability of running of the engine is very great because the working process is simple and may be grasped by the most unskilled engine attendant.

Stoppages which may be traced back to the working-cycle are practically non-existent; they can only take place when the pump fails, which was never observed during the whole of the test period. If the pumps do give out the engine stops. Explosion or pre-ignitions which take place in Diesel-engines through the holding-up of the needle-valve or the failure of the compressed-air supply, are naturally done away with in this engine. Such explosions, due to any cause whatsoever, are all the more dangerous the higher the compression pressure is in the cylinder, as the whole machine is designed to resist the highest pressures obtained in the cylinder. These must be taken as the basis of the engine design.

The reduction of compression-pressure also means a considerably reduced friction loss, which is easily seen from the diagrams. Above all, constant high-pressures in the cylinder bring about increased expansion, due to the heating of the

Nº of Observation / Nº of Diagram	Time of Observation	Weighed Amount of Fuel Oil	Electrical Output: Amp	Electrical Output: Volt	Electrical Output: KW	Output in H.P. 7 Dyn = 0.91	Revs per Min.	Consumption per H.P.	Remarks
1	6 20'35" 6 44'45" 24'10" 31.1.17	5	170 175 180 175	236 235 234 235	41,1	61,5	174	202	Temp of Exhaust 360°C Exh Smokeless
2	7 43'50" 8 28'10" 44'20" 31.1.17	8	170 170 160 168	241 241 244 242	40,6	60,6	175	194	"
3	9 52'43" 10 18'20" 25'35" 31.1.17	5	160 165 163 163	242 242 242 242	39,4	59,0	174	198	Exhaust Temp 380°C
4	12 57'45" 1 21'55" 24'10" 1.2.17	5	170 170 175 172	245 243 242 243	41,8	62,5	180	200	"
5	1 57'20" 2 19'45" 22'25" 1.2.17	5	188 190 185 189	242 242 242 242	45,7	68,4	180	195	Governor fast due to screw coming out.
6	4 32'40" 4 55'30" 22'50" 1.2.17.	5	170 165 180 172	238 240 242 240	41,3	61,6	174 174 179 176	214	Exh. Temp 380°C
7	6 01'40" 6 24'50" 23'10" 1.2.17	5	190 190 190 190	238 238 235 237	45,0	67,2	177	193	
8	8 04'00" 8 27'30" 23'30" 1.2.17	5	165 165 180 183	242 243 242 243	44,5	67,0	177	190	Exh Temp 385°C
9 Diagram Nº 8	10 21'00" 10 45'49" 24'49" 1.2.17.	5	190 185 191 170 180 183	229 229 229 232 230 229	41,9	62,5	171	193	Exh Temp 355°C Smokeless except at every 25-30 puffs
10 Diagram Nº 9	1 30'00" 1 54'02" 24'02" 1.2.17.	5	185 185 193 188 188	236 236 232 231 234	44,0	65,7	174	190,5	Exh Temp 365°C 5 clear 3-4 dirty puffs
11. Diagram Nº 10	3 43'00" 4 07'35" 24'35" 1.2.17	5	185 187 187 186 188 187	232 231 231 231 232 231	43,2	64,5	172	190	Exh. Temp 365°C Exhaust better
12 Diagram Nº 11	6 35'00" 6 58'18" 23'18" 1.2.17.	5	185 185 185 186 183	234 236 236 236 236	43,1	64,4	174	200	Exh Temp 375°C
13 Diagram Nº 13	7 05'00" 7 27'57" 22'57" 1.2.17	5	183 182 185 183	238 238 241 239	43,8	65,3	175	200	Exh Temp 380°C
14	10 58'10" 11 20'20" 22'10" 1.2.17	5	185 182 182 185	238 240 240 240	44,0	65,6	175	206	Exh Temp 370°C
15	12 37'20" 1 00'20" 23'00" 2.2.17	5	180 180 180 180	245 242 240 242	43,5	65,0	175	200	Exh Temp 370°C
16	3 26'30" 4 12'10" 45'49" 2.2.17	10	180 186 182 181	240 240 240 240	43,5	65,0	175	203	"
17	5 04'15" 5 51'30" 47'15" 2.2.17.	10	175 180 180 175 177	239 242 248 248 244	43,1	64,5	176	197	Exh Temp 375°C
18	7 13'50" 8 00'30" 46'40" 2.2.17	10	190 190 180 180 185	232 [illegible] 240 240 236	43,7	65,6	176	196	Exh faintly visible
19	9 45'30" 10 32'45" 47'15" 2.2.17	10	190 190 183 188	232 232 232 232	43,6	65,5	178	193	Exh Temp 375°C
20	11 57'30" 12 43'40" 46'10" 2.2.17	10	190 180 185 185	237 237 249 243	45,0	67,2	180	193	Exh Temp 380°C
21	1 48'15" 2 34'15" 46'00 2.2.17	10	190 185 190 188	233 230 230 231	43,4	64,8	178	201	"
22	4 26'40" 5 13'55" 47'15 2.2.17	10	185 180 185 183	233 233 230 232	42,5	63,5	178	200	"
23	6 47'00" 7 32'10" 45'10" 2.2.17	10	190 188 185 188	238 238 240 239	44,6	67,0	182	198	Exh Temp 380°C
24	9 10'00" 9 33'10" 23'10" 2.2.17	5	185 186 182 170 179	237 236 239 245 239	42,8	63,9	175	202	Exh Temp 375°C
25	12 30'00" 12 52'30" 22'30" 2.2.17	5	185 187 187 186 188 187 191 187	247 244 245 244 243 242 241 244	45,6	68,1	160	196	"
26	3 30'00" 3 53'01" 23'01"	5	188 186 183 184 185	242 246 245 247 245	45,2	67,5	180	193,5	"
27	6 30'00" 6 52'56" 22'56"	5	184 183 175 180 175 179	245 242 244 244 244 244	43,6	65,1	177	201	Indicator drum not faulty registration of late ignition

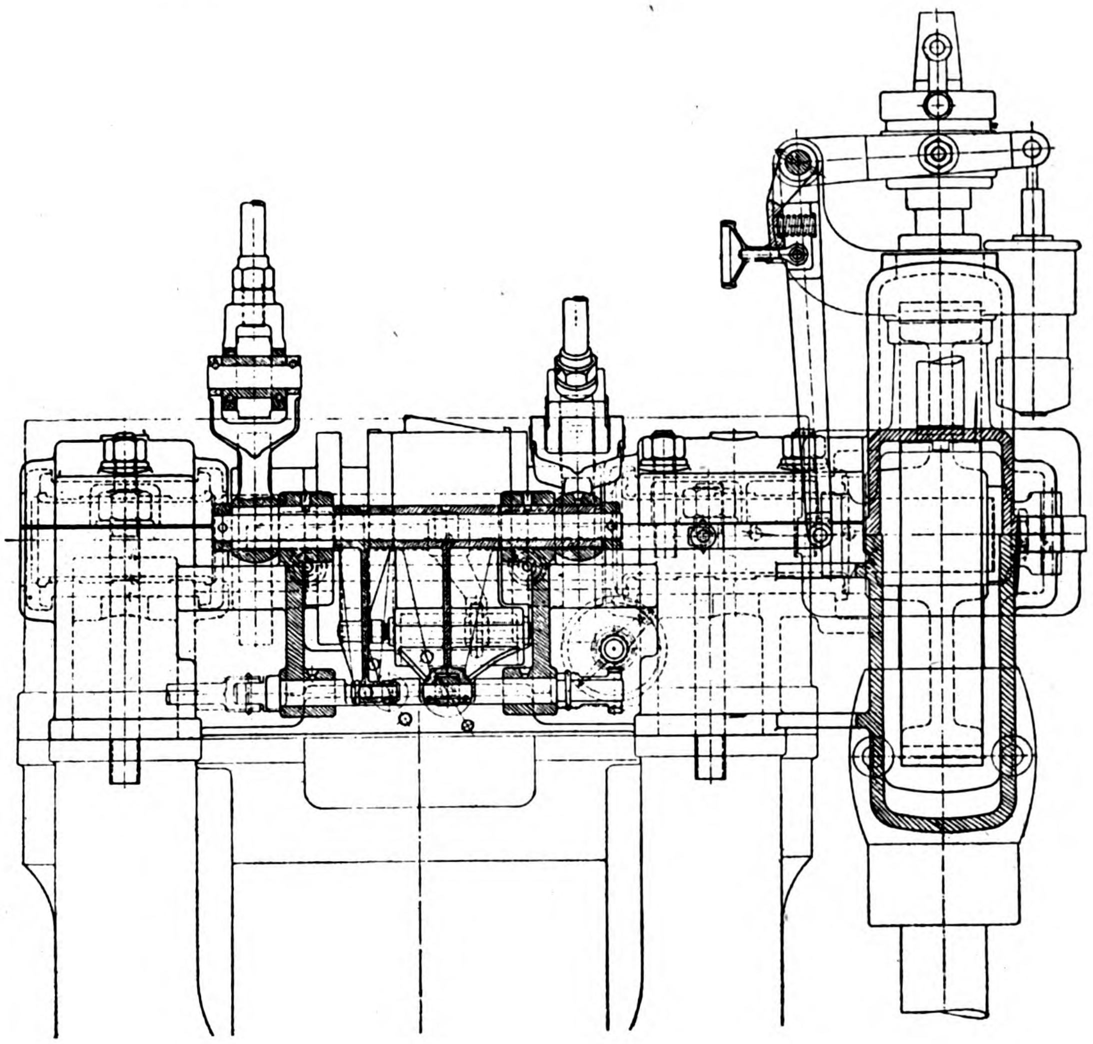
Test record of a Steinbecker oil-engine

cover, liner and piston, and a drying-up of the piston-rings. It is simply due to this fact that the construction of large power Diesel-engines is rendered very difficult, whereas the construction of gas-engines of similar powers is comparatively easy because of the smaller compression-pressures.

From the foregoing description it is seen that this process is from every point of view quite automatic. The charging of the ignition-chamber takes place automatically with the movement of the piston, so that at the moment of the injection of the oil the necessary weight of air is present. The complete atomization process, in both the ignition-chamber and cylinder, is controlled solely by the cam on the pump, the fuel itself creating its own energy of atomization at the moment of injection. This fact alone explains the great non-sensitiveness of the process to outside disturbing influences. At changing speeds this non-sensitiveness is attained in a way not previously known, no after regulation being required.

The construction of the engine in notable for the accessibility of all parts; pumps, ignition-chamber, cylinder-cover, valves, connecting-rods and levers, etc., can be very easily dismantled and built up, also the cylinder cover can be removed very quickly by unscrewing a very few bolts and screws.

The following test sheet shows the collected results obtained from the before-mentioned official tests of the Reichs-marine-amt from 31st January, 1917, to 3rd February, 1917. The indicator diagrams belonging to this test are also shown. In order to follow more closely the process of combustion going on in the cylinder, special extended diagrams are taken, as per example No. 16. Here the ordinary diagram and the special extended diagram are drawn together. The diagrams are not calculated out for indicated and brake horsepower because the indicating apparatus was not considered reliable enough to give exact results. The fuel consumption of the small engine for this test was only 190-206 grams per H.P. hour.



Valve mechanism and cylinder-head of Steinbecker engine

FLETCHER'S CONSTANT-PRESSURE OIL-ENGINE

Experiments are being conducted by Mr. Harry Fletcher of the W. & A. Fletcher Company, ship repairers, of Hoboken, N. J., on a marine design of constant-pressure oil-engine along a super-Diesel line, from which a card similar to that of a steam-engine is expected. A single-cylinder is nearly completed.

American-Engined Tug in British Guiana

Performance of the P. R. Ingersoll-Rand Solid-Injection Powered Tow-Boat "Seba"

TAKING into consideration the fact that in tug-boats the fuel consumption of steam-machinery is shown in its most wasteful and uneconomical form, the general practice being to exhausting steam into the atmosphere through "sky-condensers," it is rather surprising that the heavy-oil engine system of propulsion has not been adopted to a much greater extent than it has been in this country to date. There are hundreds of gasoline and distillate burning motor-tugs plying our harbors and shores with remarkable consistency, but there are only a few that are equipped to use the cheaper and lower grade fuel. Furthermore, it is somewhat surprising that the oil-engine drive with electric transmission has not been tried for tug propulsion as its flexibility particularly lends itself to the particular conditions of towing.

Because of this strange psychological trait that exists among our tow-boat owners no astonishment need be felt from the fact that the first P. R. Ingersoll-Rand oil-engine to be installed in a tug is owned in British Guiana. This vessel is the "Seba," built at the Nassy Shipyard, Georgetown, and owned by the British Guiana Government. Her leading dimensions are as follows:

75 ft. length over all.
18 ft., 6 in. beam.
6 ft., 3 in. Draught.

Native woods have been used throughout in building. Mora wood has been used for structural timbers, and the side planking is of green-heart.

The main engine is a six-cylinder, four-cycle type, 220 B.H.P., directly-reversible Ingersoll-Rand oil engine of the moderate compression type with solid-injection of fuel. The maneuvring air-compressor, bilge-pump and circulating-pump are driven from the main engine crank shaft. An emergency outfit consisting of a 9 horse-power vertical engine with air-compressor and centrifugal auxiliary-pump is also provided. The installation was completed on May 15th and on May 21st the "Seba" was taken over by the British Guiana Government.

The "Seba" was immediately placed in service and her initial trial voyage was her maiden working trip. At 8:30 A. M. on the 21st, lines were cast-off and the "Seba" with three empty punts in tow got under way for Christiansburg, about 72 miles distant. The destination was reached at 10:00 P. M.—thirteen-and-a-half hours having been required to make the trip. This gives an average speed of 5.34 miles per hour, which is very good, considering the fact that the tug had to breast a heavy spring tide all the way. These conditions were especially chosen as they were considered the most unfavorable that she would meet in service.

At 3:00 P. M. on the 22nd she got under way with three loaded punts for Georgetown, arriving there at 2:30 A. M. The average speed for this trip was therefore 6.26 miles per hour. The second trip was made on May 26th with one empty punt. An average speed of 12.4 miles per hour was made. The return trip the "Seba" had four loaded punts in tow and averaged 6.13 miles per hour.

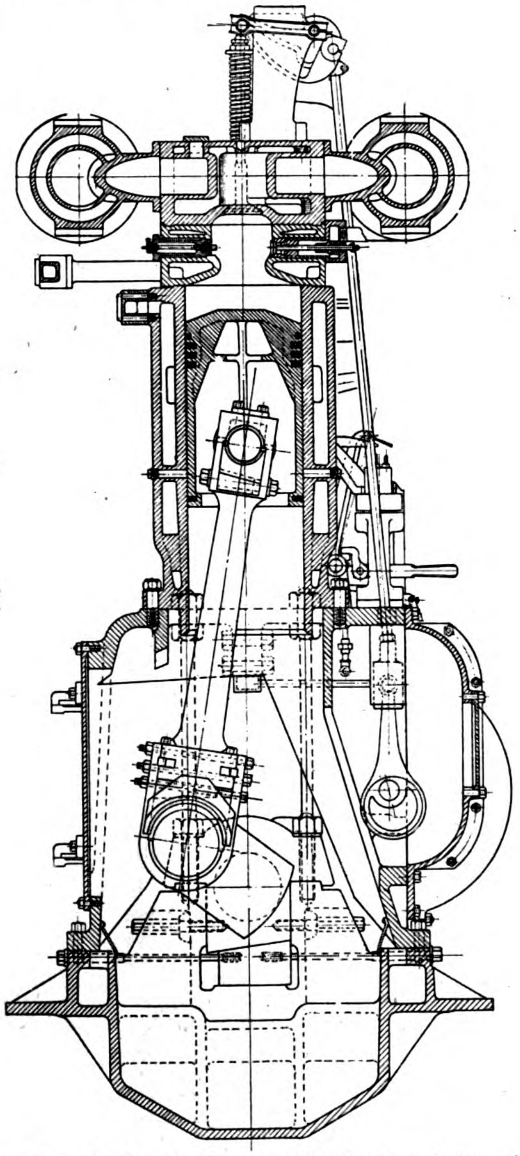
On May 28th the final working-test trip was held. A number of British Guiana officials were aboard including the Secretary of State, the Director of Public Works, Mr. Cephas Whitney, who had the contract for the tug, and Mr. Holme, erecting engineer and Ingersoll-Rand representative. For two hours the "Seba" was put through a milling test. The engine responded instantly to every demand.

The motortug "Seba" owned by the British Guiana Government

The Secretary of State "criticized" the performance of the main engine in the expressive statement that it handled as well as a steam-engine.

On the 29th of May, the "Seba" left for Seba, British Guiana, with four empty barges in tow. Mr. George Christie, the Chief-Engineer, makes the following report:

"The running was very difficult on account of the shallow water. During the last thirty miles between Christiansburg and Seba she touched bottom several times and it seemed as though the engine-bell was ringing continuously. I am glad to be able to say that the engine never failed to respond. On the return trip to Georgetown, the 'Seba' towed six loaded punts. These punts are 56 ft. long, 16 ft. beam and 6 ft., 6 in. draft and weigh empty 50 tons a piece. Each will carry 50 tons of stone so that the 'Seba' was towing 600 tons. With this load she made an average speed of 4.33 miles per hour.



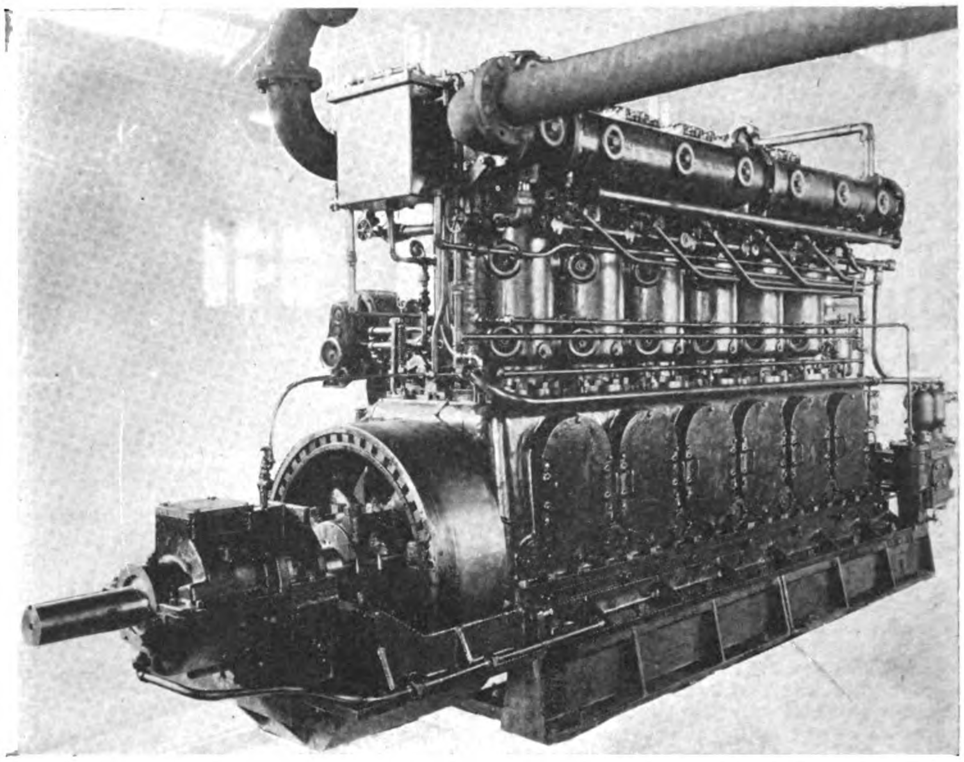
Section of the P. R. Ingersoll-Rand marine oil-engine

"I have not been able to make any very accurate fuel-consumption tests as yet. On the last trip the engine used a little less than eleven gallons per hour, developing her full power of 220 brake horse-power. This would give consumption of 0.366 lb. per brake horse-power hour which is considerably less than the maker's guarantee; but, I do not believe my figures can be far out of the way.

"I am particularly pleased with the way the engine responds. There is absolutely no hesitation; it starts up instantly in either direction. It is also possible to start slowly so as to avoid putting a parting strain on the tow line."

The reversibility of the Ingersoll-Rand engine has been emphasized so strongly in the reports that it may be perhaps well to describe in a few words how it is done. There are no double sets of cams for ahead and astern motion. The intake and exhaust valves are identical in construction and both the intake and exhaust manifolds are water cooled. When the engine is reversed, the functions of the intake and the exhaust valves are simply interchanged. The intake valves going "ahead" become the exhausts when running "astern," and similarly with the exhaust valves.

On the test stand, seven seconds is the average time required for reversing from full-speed ahead to full-speed astern. The 220 h.p. engine, which is rated to develop its load at 300 R.P.M. can be throttled down to 85 R.P.M., all cylinders firing. By cutting out one, two, and three cylinders, even greater reductions in speed can be obtained. Incidentally we may mention that the same type of engine is built in 300 and 500 shaft horse-power for larger or more powerful tug-boats.



Starboard view of P. R. Ingersoll-Rand engine, showing Kingsbury thrust-block

As we have referred to the question of electric-drive for tugs, we will point out that the Ingersoll-Rand engine is adaptable for direct-drive or for electric propulsion, in accordance with owners' requirements. Its operating cycle differs from those of the surface-ignition and Diesel engines, inasmuch direct fuel-injection without air is used with only a moderate cylinder compression of 200 lbs. per sq. inch, yet there are no hot-bulbs, or hot-plates, and an electric-igniter is only used for a brief period when starting.

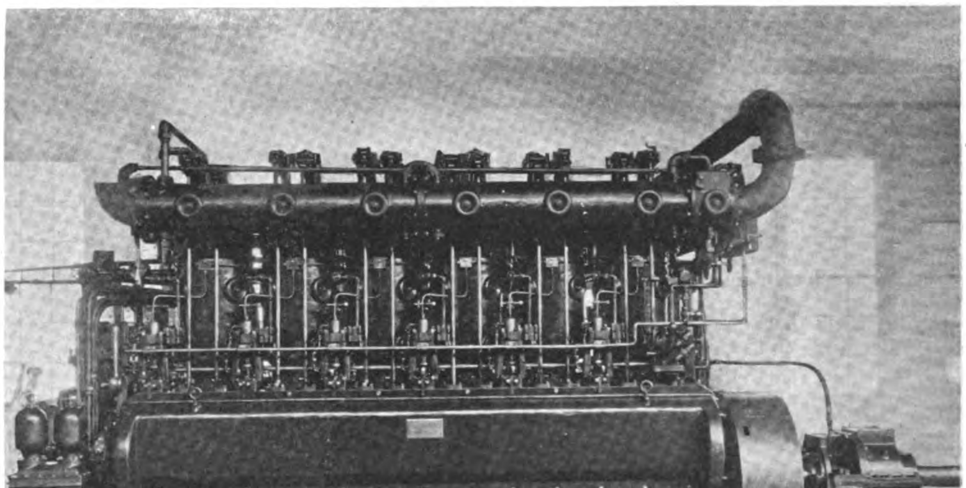
In starting electric-igniters are employed for the first few revolutions of the engine, while compressed air under 150 to 200 pounds pressure is admitted to each cylinder in succession by the aid of mechanically-operated starting-valves, to turn the engine over. As the engine is turned over fuel is injected and after a few revolutions the air is shut off, electric-ignition discontinued and the engine continues to ignite entirely by compression. The electrical igniters are required only in starting the engine when cold and the compressed air merely for giving the engine the initial impulses.

The igniters are not required when manoeuvring. The engine may be stopped for about 10 minutes, and started again without the use of igniters. They are required only when the engine is cold.

The fuel-injection pumps, one for each cylinder, which spray the fuel into the combustion-chamber, are mounted on the housing adjacent to the cylinders. They are operated by cams from the side shaft. A centrifugal two-ball governor driven off the side-shaft takes control of the fuel supply when the engine exceeds a predetermined speed. It is an over-speed governor. An oil-filter, conveniently located, is provided from which the oil flows by gravity to the oil pumps. This complete filtering system insures clean oil at all times. In addition, attached to each pump is a small filter and each nozzle is also provided with one. A pump driven from the engine elevates the oil to the filter from the main supply.

SMALL CARGO MOTORSHIP FOR WEST AFRICA

A 100-ton d.w.c. cargo-carrier, propelled by a Campbell surface-ignition oil-engine has recently been completed by Wm. Chalmers & Co., Ltd., Rutherglass, Glasgow.



Port side of 220 shaft h.p. P. R. Ingersoll-Rand marine oil-engine

Thrust Bearings for Motorships

Some Interesting Details Concerning the Kingsbury Design and Installation Arrangements

By H. A. S. HOWARTH

(Part II.)

(*Continued from page* 614, *July issue*)

If the thrust-bearing is located abaft the motor it may be of any suitable type, self-lubricating or otherwise as desired, as shown in Figs. 5, 10 and 11.

The thrust-bearing illustrated by Figs. 11 and 12 is the simplest and most compact form of horizontal self-contained self-lubricating Kingsbury thrust-bearing combined with two guide bearings. The thrust-shaft (not shown) is provided with an integral thrust-collar that revolves in the enlarged housing-space between two guide bearings. This collar dips into the oil and carries it to the top of the bearing, where it is distributed by a U-shaped scraper that rides on top of the collar.

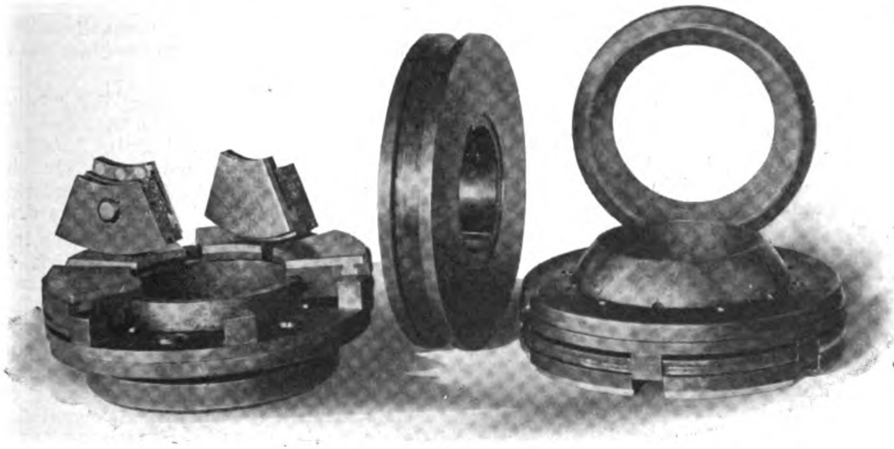


Fig. 7—Double Horizontal Thrust Bearing. Leveling Washer Type

Most of the oil is thrown down the sides of the collar and is distributed over its faces so that it lubricates the shoes abundantly. Part of the oil is deflected into each guide bearing. Two babbitt-faced shoes, with hardened steel inserts in their backs, bear against each face of the thrust-collar and transmit the load through the adjusting screws to the housing. In the simple type illustrated no stuffing-boxes are used. They can be provided if desired. The filling-hole in the rectangular top plate, the oil drain-plug at the base, and the oil-gauge are clearly illustrated.

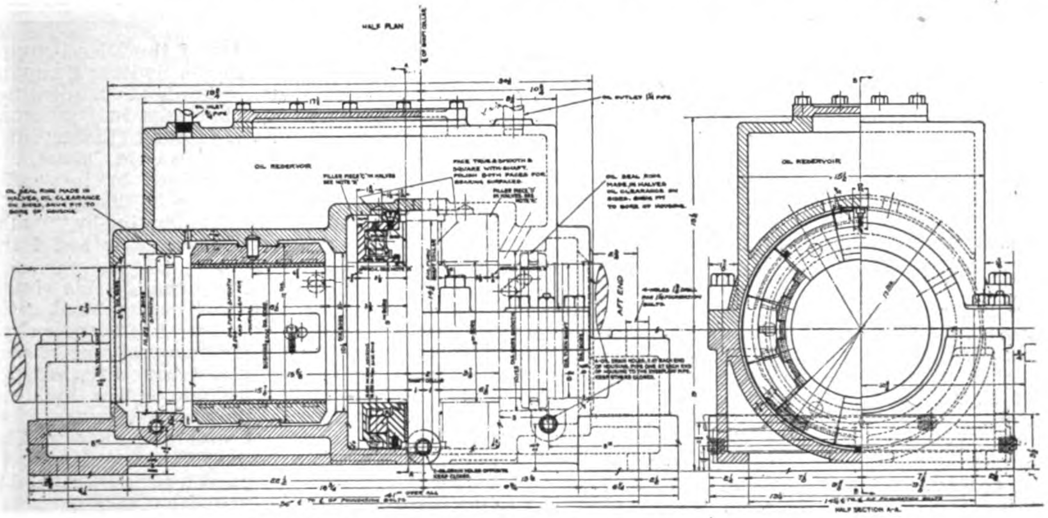


Fig. 9—Self-Aligning Thrust and Guide Bearings

The thrust-shoes bear against one-half of the collar-face on each end. The thrust against the housing is therefore below the shaft axis, near the supporting flanges, which is an advantage. Equalization of the pressure on the shoes is obtained in the manner shown by the developed section in Fig. 5.

In the surface ship type of Diesel-electric drive, the engine-generator unit is separate from the electric-motor and propeller-shaft. Consequently the thrust-bearing may be located on the forward end of the electric-motor shaft in the same way that it is applied to the forward end of a reduction-gear shaft, as previously described with Figs. 6 and 7.

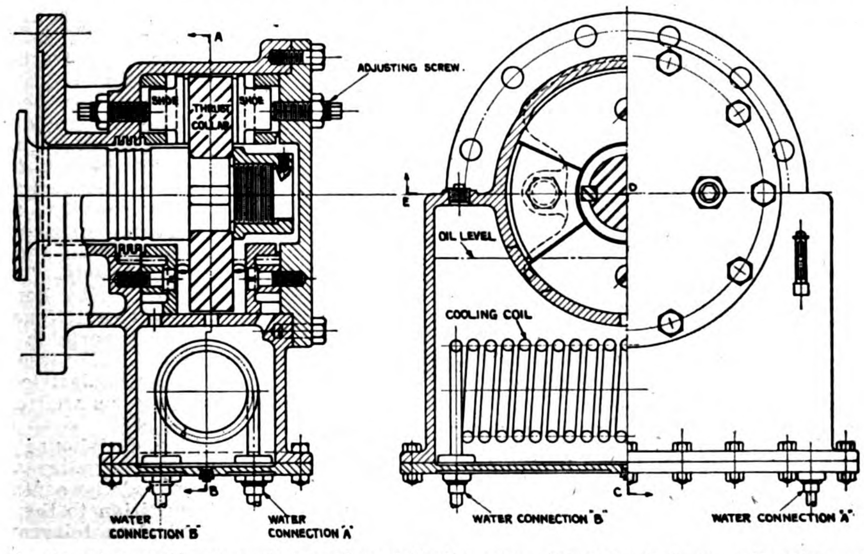


Fig. 8—Bearing with two shoes diametrically opposite mounted on adjusting screws

The first direct-driven motorship to be equipped with Kingsbury thrust-bearings was the "Maryland," owned by the Texas Steamship Company. Her deadweight tonnage is 4500 and she is driven by two 300 B. H. P. McIntosh & Seymour Diesel-engines. These were installed the latter part of 1918. The thrust-collar is integral with the crankshaft and the thrust bearing housing is integral with the engine bedplate.

Early in January, 1919, the "Maryland" made a voyage from New York to Port Arthur, Texas,

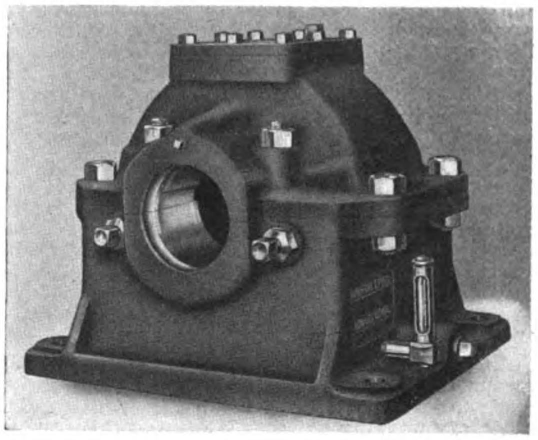
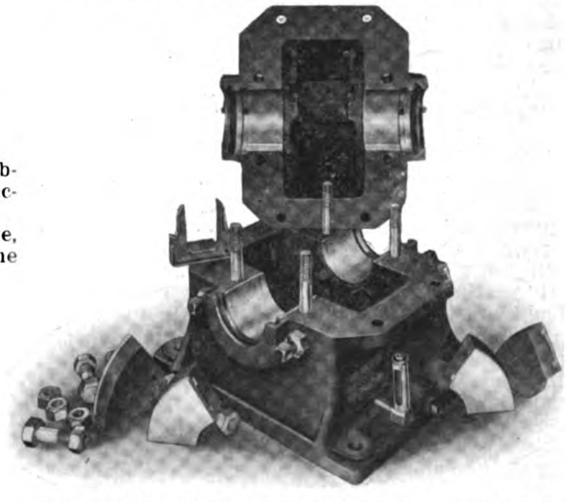


Fig. 11

during which a log was kept of the operation of the Kingsbury Thrust Bearing. Ursa oil was used. It has a viscosity of 680 seconds S. U. V. at 100° F. The average r.p.m. during the voyage was 248 and the speed 7 knots.

It was found that for steady running conditions of the engines, the thrust bearing, which depended for cooling solely on radiation to the surrounding air, would settle to a definite temperature, depending on that of the air. After about a day's steady running, it was found that with an air temperature of 60° F. the bearings operated at 125° F. As the vessel proceeded south both temperatures showed a general tendency to rise until, at a point somewhere off Florida, both temperatures reached their highest values; namely, 88° F. air temperature and 138° bearing temperature. During the remainder of the voyage the temperature showed a gradual decrease.



Figs. 11-12—Horizontal self-contained self-lubricating Kingsbury thrust-bearing combined with two guide bearings

With oil of such high viscosity as the one used on this particular vessel, the bearings would certainly operate air-cooled with perfect safety at temperatures well above 150°.

It should be noted that this bearing was filled with lubricating oil at the outset and operated thereafter without any further supply. There was no steady flow of cool oil from and to any outside

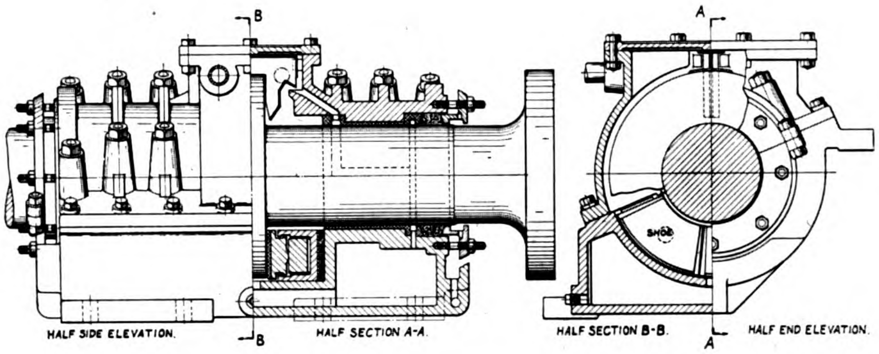


Fig. 10—Self-contained thrust-bearing—submarine type

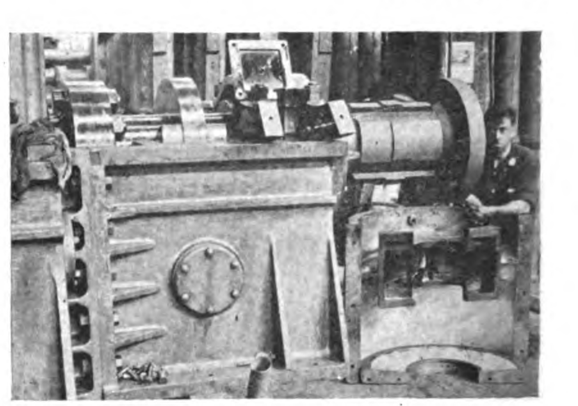


Fig. 13—Thrust-bearing mountings of a Skandia-built Werkspoor Diesel-engine of 1150 i.h.p.

source to carry away the heat. Neither were there any cooling coils in the base of the bearing.

The thrust bearings were inspected at the end of the voyage and were found to be in precisely the same condition as at the beginning. There had been no perceptible wear on the bearing faces. Up to the time of writing, the "Maryland" has traveled 34,420 nautical miles, the thrust-bearings are still working perfectly and there has been no perceptible wear on the thrust-bearing faces.

When a rigid seating is not available for this bearing its base can be made longer and with more bolt holes. If used in a tug-boat, for example and mounted on a timber seating, the guide-bearings may be omitted from the thrust-bearing housing so as to guard against overheating because of the misalignment that is likely to occur. Stuffing-boxes may be used to keep water out of the thrust bearing.

A long base need not be used when adequate means are available for transmitting the thrust-load from the bearing to the engine bedplate. The mode of fastening varies. When the thrust housing contains a guide bearing to help carry the weight of the flywheel the connection should be very rigid, or integral with the engine bed. When the flywheel is forward, a less rigid connection is required. A common method in use in tug boats is to extend two studs from the engine bed to lugs on the thrust housing. This arrangement may permit of endwise adjustment. Another feature of the illustrated construction is the thrust-collar, which is made integral with the hub of the coupling, the hub diameter being reduced where it passes into the thrust housing to the collar.

The illustration Fig. 13 shows the thrust-bearing mountings of a Skandia-built Werkspoor Diesel-engine of 1150 I. H. P. Two of these four-cycle type Diesel engines have been built for the Standard Oil Company of California's tanker "Hillman" which is of 5010 tons d.w.c. and which is now being constructed by the Moore Shipbuilding Company.

Among other American motorships which have Kingsbury bearings are the Texas Steamship Company's auxiliary "Maryland" of 4500 tons; the "Texaco 146" of 1000 tons, the "Texaco 147" of 1000 tons. Then there is the Vacuum Oil Company's tanker "Bramell Point," 5000 tons. Two other motorships which have Kingsbury thrust-bearings are the "J. F. Penrose" of 4500 tons d.w. and the "Kamchatka" of 1500 tons d.w.

In addition to the foregoing there is the wooden motorship "James Timpson" which is propelled by two-500 h.p. Winton Diesel-engines in conjunction with Falk reduction-gears. Also the Mc-Intosh & Seymour Corporation have built five Diesel-engines of 750 shaft h.p. each equipped with Kingsbury bearings. Furthermore, a 300 shaft h.p. Diesel-engine which the same company recently shipped to Hibbard, Swenson & Co. of Seattle, is equipped with Kingsbury thrust-bearings. The largest marine Diesel-engine yet completed in America on which the Kingsbury bearing is fitted is the 2400 I.H.P. Worthington engine which was described in the June number. It is probable that the same type of thrust-bearings will be installed on some Diesel-engines now being laid-down in this country up to 3000 shaft h.p.

Electric Pyrometers for Tuning Diesel Engines, Close Regulation and Smooth Running Easily Obtainable

WHEN the exhaust temperature of a marine Diesel-engine or any internal-combustion engine is known, a very accurate insight into the internal working conditions obtaining in the cylinder may be had. An indicator card gives the working-pressures for a single cylinder during a single cycle, whereas a continued study of the exhaust as to color and temperature will give conclusive knowledge as to just what adjustments should be made in the valve-gear—especially the fuel-valve.

An increase in the exhaust temperature of one cylinder over the other indicates several things—first the opening of the fuel-valve may be too great allowing an excess amount of oil or if the fuel admitted for stroke is accurately controlled before entering the fuel-valve, the reverse may be implied, i. e., the valve in the cylinder having the lower exhaust-temperature is not working properly.

Perhaps the injection is late or the injection-air low, so that late burning occurs with consequently a hot exhaust. If the water circulation is poor, that fact can be quickly determined by feeling the jacket, head, or the discharge from that particular cylinder. In any event there should be thermometers provided in the individual water circulation discharge. If the piston-rings are struck, or leaking, for any reason, the noise will generally be heard in a large engine that runs slow enough to allow opening the crank-case a little. If it is possible to get close to the inlet-valves on each cylinder, a comparison in the ring of the explosion or rather combustion during injection in each cylinder will indicate if all cylinders are "firing" evenly.

With a pyrometer equipment so installed that separate thermo-couples are fitted in each exhaust and wired to a master switch so that a single air-meter can be connected to each cylinder quickly and in rotation, an ideal arrangement would be provided for this system.

The great difficulty in operating a multi-cylinder engine is to get uniform and regular power output on each crank. It is hardly possible to make any direct comparison of all cylinders simultaneously and even indicator cards only do what their name implies—they indicate the way in which the cylinders are working. A thermo-couple accurately measures the temperature of the exhaust—a function of any gas that really tells more about its energy context than either the pressure or volume alone. To know the heat context or energy lost in the exhaust is to arrive very close to knowing definitely the working conditions prevailing in the cylinder during combustion and expansion.

It may be well before going further to say that the principle of measuring temperatures electrically is based on the well-known property of certain metals or alloys. For a temperature range up to 1,000° F. an alloy of copper and a metal called constantan is used by one maker. This alloy is usually made up into a rod of a length sufficient to provide that one end (the hot junction) will be in contact with hot gases and the other (the cold junction) will be at room temperature and preferably as low as possible. The difference in temperature of the two ends produces a difference in electric potential which causes a current to flow. This current is led to a milli-voltmeter and thus the strength of the current in thousandths of volts as shown by the dial will indicate, and accurately so, the temperature at the hot junction. For a temperature of 1,000° F. a current of 30 milli volts will be generated.

The features of the scheme are accuracy, simplicity, not cumbersome to install, fairly rugged with ordinary care and adaptable to multiple installation. Thermometers though heretofore reliable and still to be recommended are liable to break and usually stick out like a sore thumb.

It has been emphatically stated by an engineer in charge of testing high-powered submarine engines that he has absolute confidence in the system and is greatly impressed with the improved running and output to be obtained after regulating the valves and injection air-pressure to obtain uniform exhaust-temperatures from all cylinders. There exists an opportunity for makers of electric pyrometers to acquaint oil-engine builders with the merits of their instruments through the medium of the publicity columns of "Motorship."

THE SWEDISH DIESEL-POWERED SALVAGE SHIP

(By Our Scandinavian Correspondent)

Recently "Motorship" announced that the Götaverken had received an order for a high-powered Diesel-driven salvage motorship. Several months ago the writer of these lines was privileged to discuss the possibilities of the Diesel-engine in the salvage business with the Switzer Company of Copenhagen, Denmark, who hold a dominating position in the salvage business in Scandinavian waters and even are a strong factor in the Mediterranean and other waters abroad. The obvious advantage to be gained by internal-combustion power, in that there is no fuel-consumption when a salvage ship is "standing-by," was opposed by this firm because of their belief in the necessity of steam-boilers.

Competition will probably change this view now that the Swedish "Red Co." has entered into the competition with every prospect of success through its order for the Diesel-driven salvage motorship referred to. Located in Goteborg this latter company has probably been stimulated in this decision by its association with the Brostrom interests, which own a number of motorships and which will be connected with the world's largest motor-liner which is now being planned for the Swedish-American Line.

As announced, the new salvage motorship is being built at the Götaverken and will be completed during August. Her dimensions are as follows:

Length O. A.	166 ft., 8 in.
Length B. P.	156 ft., 1 in.
Breadth	34 ft., 9 in.
Moulded Depth	18 ft., 7 in.
Power	2500 I.H.P.

Ample space is afforded on the deck for the various salvage equipments. Tanks are fitted both fore and aft and on both sides of the rear compartment in addition to two large fresh-water tanks, while the double-bottom holds 100 tons of fuel-oil. There is a donkey boiler and for the same 20 tons of oil are provided. The after hold for the salvage-tools has a capacity of 8,000 cu. ft. and the front hold has a capacity of 4500 cu. ft.

On the deck there is a cable-winch and a loading-winch of 10 tons lifting capacity, also a steam-windlass. Two large 14 in. electric-driven centrifugal-pumps will be installed in the engine-room in addition to three portable sets. There also will be three 8 in. pumps driven by kerosene-engines and one 12 in. steam-driven centrifugal pump. Also there will be two transportable Worthington pumps, the total capacity of all these sets amounting to 5,500 tons per hour. Electric light will be fitted throughout the ship, as well as a powerful searchlight.

Amidships there is a deck-house and a mess-room for the officers, also a galley and bath. At the bridge-deck is arranged the captain's quarters and a spare cabin in addition to the compartment for navigation and wireless telegraphy. Astern, below the main-deck are the crews' cabins and mess-rooms and a carpenter shop.

Scavenging In Two-Stroke Diesel Engines

The Experiences of a Great French Engineering Firm

By Messrs. Schneider et Cie, Le Creusot

THE principal of operation of two-stroke Diesel engines is well known. The cycle is composed of the following stages:

First stroke. Injection of fuel, combustion, expansion and exhaust of the burnt gases.

Second stroke. Scavenging of the burnt gases, introduction of pure air and compression.

A little above the lower dead center the piston uncovers exhaust-ports arranged ring fashion around the lower part of the cylinder. The products of combustion are then swept out and the pressure in the cylinder falls rapidly to about atmospheric pressure.

Scavenging-air under low pressure is admitted at this moment and drives in front of it the last products of combustion, thus assuring that the cylinder be filled with pure air during the time that the piston, after having passed the lower dead center, has risen and covered the exhaust ports.

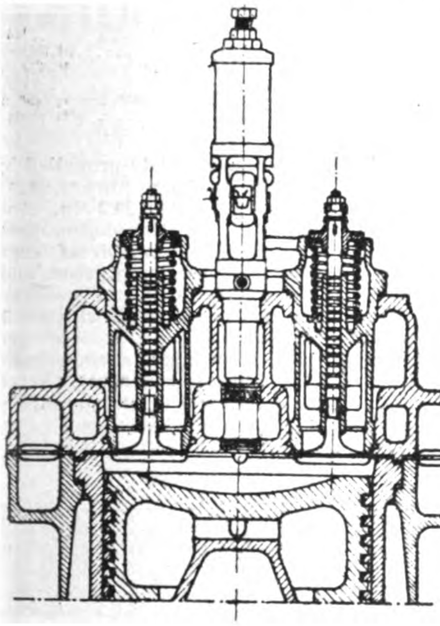


Fig. 1

The entry of scavenging-air ceases a little before the ports are completely covered. The fresh atmosphere then contained in the cylinder is compressed by the piston as far as the upper dead center; the injection of fuel is effected, and the cycle continues to pass through the same phases.

The scavenging-air is generally furnished by reciprocating pumps driven directly by the engines. In certain exceptional cases this air can be supplied by pumps or by blowers driven either electrically or by an individual engine.

The introduction of the scavenging-air into the cylinder is carried out according to the design of the engine by one of the two following methods.

(A). Through the upper part of the cylinder by means of valves opening therein and situated in the cylinder-head.

(B). Through the lower part of the cylinder by means of ports placed opposite the exhaust-ports and timing devices such as valves, slides, etc.

Advantages and Drawbacks of the Two Systems

System A. This arrangement assures a perfect cleansing of the cylinder. The valves, arranged in the head in such a way as to avoid any neutral cone that is not scavenged, permit the introduction of a virtual piston of air, that driving in front of it the burnt gases, which to some extent become stratified with the pure air, assures a complete sweeping-out of the exhaust. In this way when the working-piston again covers the ports the cylinder contains a charge of absolutely pure air.

From the fact of the stratification just mentioned and if the exhaust ports are judiciously designed, the volume of scavenging-air can be relatively small and only moderately exceed the volume of the space represented by the piston movement. This condition is very advantageous from the point of view of the power absorbed by the air pump.

Finally, after the expulsion of the burnt products the fact that the cylinder contains a charge of clean air allows high mean-pressures to be realized with good combustion. There is consequently increased engine power.

On the other hand the valves with their operating-gear form a rather complicated mechanism and this is the principal objection made against the system. As the valves are operated in a very short space of time they are subject to considerable inertia influences in high-speed engines, and through this fact are put under a noticeable strain at the time of closing.

The high temperature space which they adjoin renders them liable to deformation, but this is not so pronounced as in the case of the exhaust valves of four-cycle engines, because the scavenging valves are cooled in each cycle by the passage of the clean air. In the case of the breakage of the valve-stem the valve is liable to fall into the cylinder unless special means are devised for preventing this.

System B. With this arrangement the scavenging of the cylinders is incomplete notwithstanding the directive shape of the admission-ports and sometimes of the piston-head. The region of the combustion-chamber is never completely cleared of burnt gases; there can be no stratification between the scavenging-air and the products of combustion, so that when the piston rises to cover the exhaust ports the charge contained in the cylinder is not composed solely of pure air as in the other system, but contains also a certain quantity of inert gases. The volume of the scavenging-air entered is also considerably greater.

One can not, therefore, even with good combustion obtain such high mean-pressures and consequently so much engine power as in the other case. The timing elements and other mechanism present a simpler aspect than the overhead valve-mechanism and do not entail the use of such a complicated cylinder-head.

It is, however, to be noted that these parts frequently give trouble, particularly in the case of rotary valves, the lubrication of which can never be more than precarious by reason of the carbonization of the oil in contact with the hot gases.

System Used on the Schneider Engines

A profound examination of the advantages and drawbacks of the two systems has led Schneider & Company of Le Creusot and Harfleur to adopt the method of valve scavenging. Numerous floor tests, particularly with high-speed engines, have enabled them to determine the most rational shape to be given to the valves, to their seats and to their cams and driving mechanism. The best metals have been selected for the construction of these parts, so that their behavior and operation give the most complete satisfaction.

In this connection it may be stated that the many engines turned out from these works, including the submarine types which operate with speeds up to 400 revolutions per minute, have always given the best results. For slow-speed motors and even medium speed motors, say from 100 R.P.M. to 250 R.P.M., the design of the valve system does not present any difficulty, the inertia effects of the moving parts being relatively unimportant.

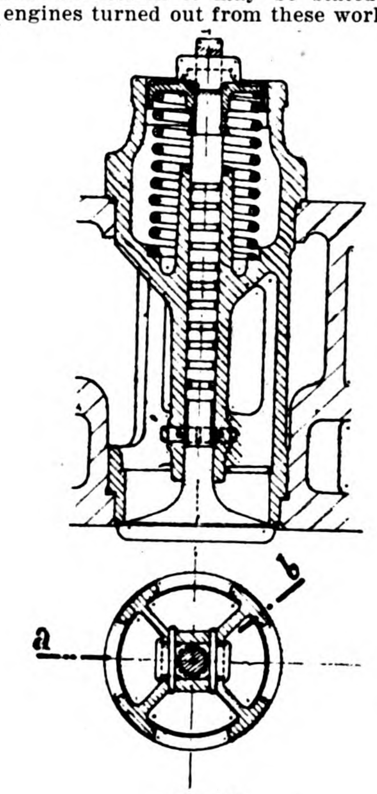


Fig. 2

In figure (1) is shown a section of the cylinder-head through the scavenging-valves, while figure (2) shows a section to a larger scale of a scavenging-valve.

One can observe that the valve-stem shows no fillets which in fact are liable to form planes of fracture, so that it is important to avoid them.

A simply secured key holds the spring-cup in place and the valve can therefore be very quickly and easily removed and put back. The safety device in the shape of a fork mounted on the base of the stem guide prevents the valve from falling into the cylinder, in the improbable event of the stem breaking. The valve seats can be easily ground and their tightness is therefore always assured. The profile of the cams has been very carefully designed to avoid prejudicial shocks at the moment of opening or of closing of the valves.

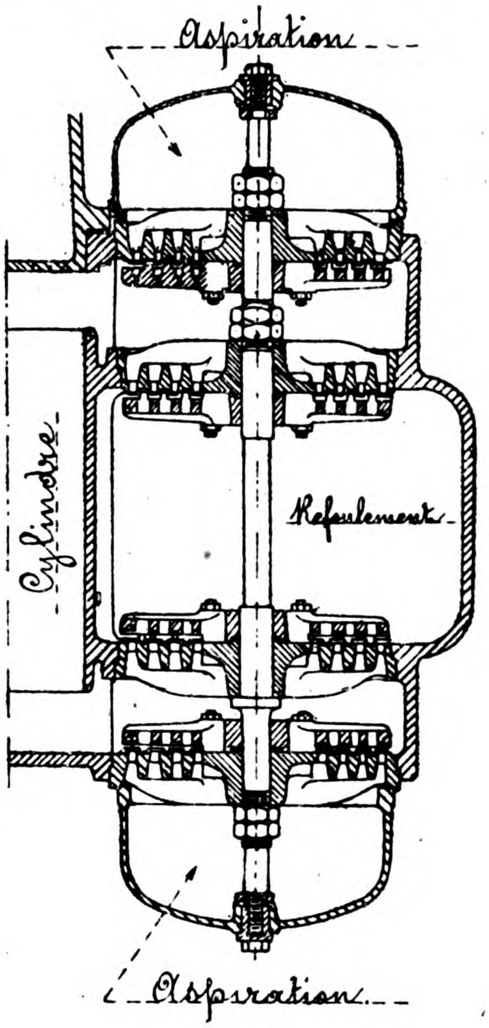


Fig 3

Scavenging-Pumps

In principle the Diesel engines built by Schneider & Company are supplied with reciprocating scavenging-pumps, the number of which varies according to the number of working-cylinders. These pumps are double acting and are driven directly by the crank-shaft in the case of high-speed engines, or by connecting-beams in the case of slow-speed engines, and particularly of cross-head engines.

They are provided with automatic plate-valves both for suction and for delivery. The form of these is shown clearly in figure 3. They are placed one above the other in greater or lesser number according to the size of the pump. These valves are designed for large passage areas both on the suction and on the delivery, in order to reduce to a minimum the resistance at the valves and to give the pump the highest volumetric and mechanical efficiency. Their assembly on a single valve stem enables them to be very easily withdrawn for inspection and replaced. Further it may be noted that the delivery chamber is of large dimensions, both for the purpose of serving as an air reservoir and for equalizing the pressure.

In sum, the question of scavenging in the two-cycle engines built by Schneider & Company has been solved in the most rational fashion and in a way to give the best guarantees in all respects, as has been fully demonstrated by the excellent results obtained with the numerous equipments of this type sent out by the works and now in service.

AN EXCELLENT LAW

Under the Italian law no Italian sailing-vessel is allowed to operate in deep-sea trade unless she is equipped with auxiliary propelling machinery.

SULZER MARINE DIESEL ENGINE ON EXHIBITION IN LONDON

A Sulzer two-cycle type marine Diesel-engine of 400 shaft h.p. is on exhibition in the Oil Section at the Victory Exhibition, Crystal Palace, London, England.

MOTORSHIP OF 10,000 TONS FOR FRITZOES CO.

A motorship of 10,000 tons d.w.c has been launched at the Rosenberg mek verksted, at Tonsberg to the order of the A/S Fritzoes of the same city.

EAGLE OIL PURCHASE MOTOR TANKER "SAN DARIO," EX "TEAKOL"

The 640 b.h.p. Bolinder-engined naval motor-tanker "Teakol" has been sold by the British Admiralty to the Eagle Oil Transport Co. of London. She has been renamed "San Dario."

MARINE ENGINES IN SWITZERLAND

Owing to the increasing demand for Diesel marine-engines, Lloyd's Register of Shipping have, at the request of Messrs. Sulzer Brothers, appointed Mr. W. G. Vallis as ship and engineer-surveyor for Switzerland, with residence in the district of Winterthur.

"OIL NEWS" ADDS ITS WEIGHT TO OUR CAMPAIGN

Foreign countries are building motor-driven ships for freight carriers and if our new Merchant Marine is to compete with European freighters we must discard steam as a propelling force. Our Merchant Marine will ultimately be driven to its use and this nation with its superior mechanical genius should lead the world in its design and manufacture.—*Stephen O. Andros, Editor Oil News.*

BRITISH MOTORSHIP COVERS 400,000 MILES

To date the British twin-screw Diesel motorship "Jutlandia," 7,500 tons d.w.c. has covered about 400,000 miles without a single involuntary stop of the ship at sea, and today is running excellently. Her daily consumption is 9 tons of 0.93 gravity oil-fuel and lubricating-oil 20 gallons.

THE NEW FRENCH MOTOR FISHING FLEET

With further reference to the motor fishing-vessels of which about 150 were recently ordered by the Fisheries Department, French Government, British-built engines have been installed in some of the craft. It may be remembered we urged American manufacturers to get busy and secure some of the orders.

"PRIMULA," A NEW TOSI ENGINED SHIP

Delivery of a new 3500-ton d.w.c. full-powered steel motorship has been taken by E. Massa of Savona, Italy. She was built by G. & A. Migliardi Bros. of Savona to Lloyds 100 A 1 class and is propelled by twin 600 shaft h.p. Tosi cross-head-type, direct, reversible four-cycle Diesel oil-engines, turning at 150-165 R.P.M. Her name is "Primula."

OIL-FIRED BOILER EXPERT ADVOCATES DIESEL PROPULSION

Prior to sailing for England Mr. W. A. White of the White Fuel Oil Engineering Co. told the N. Y. Times reporter that it must not be forgotten that the burning of oil under boilers is but an intermediate step to the burning of oil direct in the cylinders, as in Diesel combustion-engines which ultimately will take leading position in the marine field.

A MEXICAN MOTORSHIP

Messrs. Manuel Fernandez of Vera Cruz, who are subscribers to "Motorship" recently purchased the motorship "San Ramon" ex "Jayo" through Seabury & De Zafra, Inc., of New York. This vessel was recently delivered at Vera Cruz and is now undergoing overhauling preparatory to going into coast-wise trade. The present 120 H.P. oil-engine will be replaced by a 320 B.H.P. oil engine of American manufacture, and the work will be carried out at a New Orleans shipyard.

HIGH-POWERED MERCHANT-SHIP DIESEL ENGINES

Merchant-ship type Diesel oil-engines of 4000 shaft h.p. are now being offered by Ansaldo-San Giorgio, Ltd., of Spezia, Italy, and of 80 Maiden Lane, N. Y. A pair of engines of this power would give a passenger-cargo vessel of 15,000 tons d.w.c. a speed of 15 knots.

MOTORSHIP FOR CONSUL BLIKSTAD

In our April issue reference was made to a small motorship now under construction in Denmark for Consul Blikstad, in which vessel a Burmeister & Wain trunk piston-type Diesel engine of 450 shaft h.p. was to be installed. She is building at the works of the Nes Mek Verksted, of Tonsburg, Denmark, and has the following dimensions:

Deadweight capacity	1000 ton
Length (B.P.)	179 ft. 6 in
Breadth (moulded)	29 ft. 6 in
Depth (moulded)	14 ft
Cubic capacity (grain)	51,290 cu. ft
Cubic capacity (bales)	46,424 cu. ft
Fuel-capacity	127 ton
Cruising radius	13,800 miles (58 days
Power	450 shaft h.p

She is a single-screw ship and is propelled by a six-cylinder Burmeister & Wain four-cycle type Diesel engine 15.74 in. bore by 29.3 in. stroke, turning at 145 R.P.M. Also in the engine-room is a 45 b.h.p. Burmeister & Wain Diesel engine, which drives the reserve air-compressor and a 29 K. W. electric-generator, the latter generating current for the electrically-operated winches and the anchor windlass.

In addition there is a 10 b.h.p. surface-ignition oil-engine driving an electric-generator that furnishes current for operating the bilge-pumps and for electric-lighting the ship. The vessel is to be fitted with wireless equipment.

Solid-Injection "Diesel" Engines

Some Experiences With Their Operation

A useful paper on the care and maintenance of the solid-injection type of "Diesel" engine was recently read by Mr. David P. Peel before the Institute of Marine Engineers Incorporated, Tower Hill, London, E. C., England, and a discussion followed. Many rumors have been current regarding the "smoking" said to be a feature of the solid-injection engine, so the following remarks by Mr. Peel are of interest.

White Smoke is caused by too much air, and is easily stopped by partly closing the air-inlets or louvres in the air-supply trunks.

Black Smoke is more troublesome, as it may be caused in so many different ways, and consequently much more difficult to locate the cause. It may be due to one or other of the following:

(1) Too much lubricating-oil supplied to the cylinders. When this occurs there is a tendency for the oil to deposit on the piston-head, where, owing to the heat of compression, it partially vaporizes, and the cylinder already having had its full charge of fuel thus the added vapor being unconsumed passes through the exhaust as thick black smoke. The remedy for this is to cut down the lubricating-oil carefully to the lowest point of safety.

(2) Where insufficient air is supplied to the cylinders the burning mixture will not be in the correct proportion for complete combustion when the fuel is injected, with the result that a certain quantity of fuel, although vaporized, cannot be burnt and is passed off through the exhaust as black smoke. One cause of this may be the throttling of the air supply by the louvres, or again, the passage of air may be restricted thus:

Where there are sharp bends in the air line, any dirt or dust, which may be drawn in with the induction, tends to lodge in these bends and, in time, forms a bar to the ingress of the air, and thus, the effective area of the inlet pipe is materially reduced. This trouble is particularly prevalent where a pipe is led from the crank-pits to the induction line, for the purpose of clearing the pits of any accumulation of explosive gas which may be generated by the running heat tending to vaporize the lubricating-oil.

Figure 1 illustrates the Vickers solid-injection sprayer valve complete, B is the actuating lever, and C the cam with toe piece G; H is the valve spindle. The brass rod D is led through the cap J and insulated from it with the sleeve E made

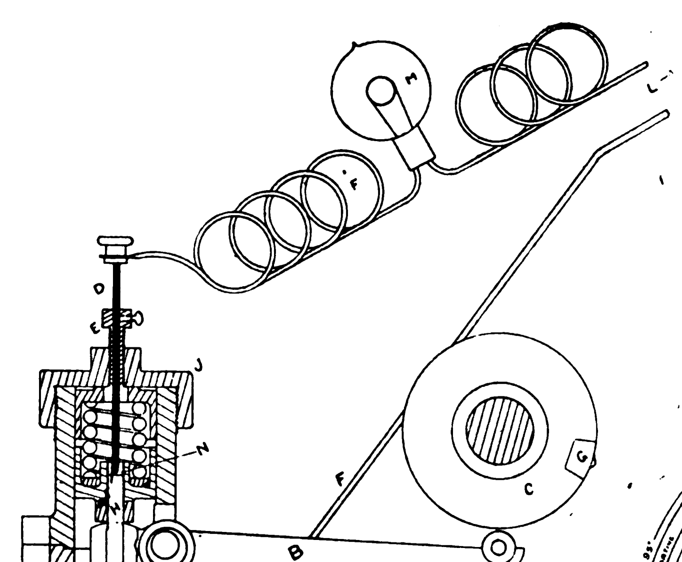


Fig. 1. Vickers solid-injection sprayer-valve

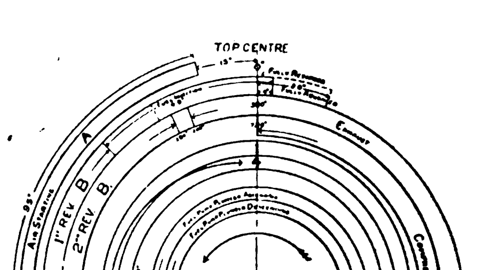


Fig. 2. Diagram of air starting (A), running cycle (BB), sequence of firing (CC), with a fuel pump of one cylinder of an 800 B.H.P. eight-cylinder Vickers solid-injection oil-engine

of non-conducting material, and screwed through the cap for fine adjustment. The rod D is set as close to the spindle H as possible without allowing an electric current to jump the gap. An electric wire F is led from the rod D and from the body of the valve to a lighting circuit or battery, with the lamp M in the circuit. The circuit is now complete except for the gap N. Let the engine now be turned by hand dead slow, and as soon as the toe piece G picks up the roller on the lever B the gap N will be closed and the circuit completed, lighting the lamp M, then the flywheel graduations are noted as previously with the air. The disadvantage of the first system is the loss of starting-air; the second is not so accurate, as the valve has to be raised a certain amount to close the gap before the lamp will light, when one degree or perhaps two will not be recorded.

Figure 2 comprises a diagram of: A, air starting, BB, running cycle, CC, sequence of firing, DD, cycle of fuel-pump of Vickers 1,000 h.p. unit engine with eight cylinders.

Unfortunately, we are unable to find space for publication of the complete paper or of the discussion, but the following remarks by Mr. B. P. Fielder, Chairman of the Committee, are worthy of reproduction.

The Chairman: "Many ships are now burning oil instead of coal to generate steam, but when one considers that the consumption of oil to do this is about three times the amount required for an equivalent horse-power developed in an internal combustion engine it is reasonable to conclude that the number of such engines used in future will increase."

"Owing to saving in weight of machinery but principally owing to the lesser weight of fuel to be carried for an equal distance traveled, a ship can carry considerably more cargo when fitted with internal combustion engines, and this is another reason why this type of engine is bound to be developed in the future.

"At the present time there is a limit of size for oil-engines, but this I believe will be increased. We are apt to compare oil-engines which are in a state of development with steam-engines which are the result of many years' experience. There were plenty of troubles with steam machinery and we still have a few, and we must expect to have others whilst progressing with the oil engine. The solving of difficulties and avoidance of the cause of these in future designs are factors which assist us to improve.

"I shall be glad to know whether there is any limit of size of the cylinder to which can be fitted solid-injection of fuel, because we would like to dispense with air compressors for Diesel engines, but I suppose we will have to retain the compressors for making sufficient air under pressure to start or maneuver the engines."

Improvement of Mouth of Mississippi Assists Operators of Motor Workboats

EXPENDITURE of approximately $12,000,000 in the improvement of Southwest Pass, the most important of the five mouths of the Mississippi River, is virtually completed, and owners and operators of commercial motor craft boats, particularly the fish and freight and passenger carriers of the so-called "Lower Coast" of Louisiana, are rejoicing that they now have a straight, narrow and deep channel to follow in getting off the Gulf of Mexico, instead of having to take any of the minor mouths of the stream, or to lose time finding their way through the mudflats of the Southwest Pass as before the improvement.

Section of the new wooden breakwater built to confine Southwest Pass, one of the mouths of the Mississippi River, to a stream 1,000 feet wide and 35 feet deep

The are five mouths to the Mississippi river. Southwest Pass handles something more than 50 per cent. of the traffic in and out of the stream; South Pass takes care of about 14 per cent., and Pass L'Outre most of the remainder, with some small-boat traffic through The Jump and Cubit's Gap, neither of the latter two being important, while both South Pass and L'Outre could be dispensed with under the new work now completed on the main mouth.

The jetties of stone and marble, which extend five miles out into the Gulf of Mexico from Southwest Pass, are approximately one mile apart. This width was found so great, however, that in many places the channel was not more than nine feet deep, while to maintain a channel of 35 feet, the minimum which would accommodate large ocean freighters, it was necessary for Uncle Sam to keep three or four dredges busy all the time in this pass. Government engineers thereupon decided to make an artificial channel within this pass which would be narrow enough to compel the mighty stream to clean itself, to brush its own teeth and wash its own mouth, so to speak, and maintain a minimum low water depth of 35 feet.

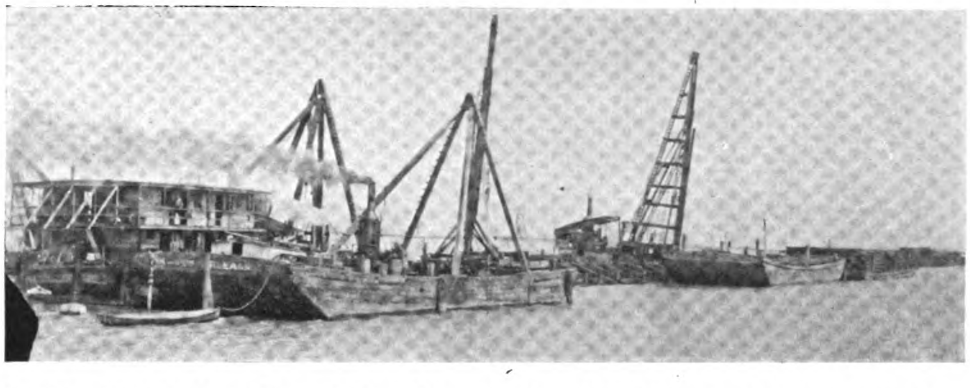
To accomplish this—and it has been accomplished—two wooden breakwaters, 1,000 feet apart and five miles long, were built down the center of Southwest Pass. They were made of 14x14 inch timbers, forty to sixty feet long, driven close together and then faced on the inner sides with Warfield sheet piling, and cross braced with angle beams of 6x6 and 10x10 inch timbers, which, in turn, were anchored to other piling set back of the line of the breakwater. Every alternate pile is driven about one foot below the surface of the water, while the others rise two or three feet above it, so that, while the high pile show the course of each of the breakwaters, and, hence, the channel, openings are left for overflow waters at flood time. This is very essential inasmuch as the rise in the river at New Orleans at time of flood is frequently 21 to 22 feet, especially when the Ohio valley snows melt or when there are heavy rains in the Ohio or Missouri river basins.

At the base of these breakwaters, hundreds of tons of "Man-size" stones and broken rock were dumped, so called because they are of 100 to 150 pounds weight, as large a size as one man can carry to the edge of the barge and dump overboard. At frequent intervals inside both breakwaters, wing dams have been built toward the center of the channel, to catch the mud, silt and sand the current brings down the river. The pockets behind these dams can be kept clean with one dredge, as against the four which have been employed to keep the main channel clean for several years.

Then, while these breakwaters were being built, Lester F. Alexander, who has the contract to do the work for the government, went back up to The Jump and Cubit's Gap, and Pass L'Outre, and dropped bottom dams in across each, leaving water deep enough for shallow draft boats to pass in and out, and to give relief for flood waters coming down the Mississippi, but dams of sufficient height to make the main current seek an outlet through Southwest Pass. These bottom dams were made by alternate layers of willow mattresses and heavy stone, some of it as much as five tons, brought from the Gantt quarries in Alabama by train to New Orleans, and thence by barge to the mouth of the river. Most of the old stone Cotton Exchange building in New Orleans, with its monster stone statues, which has been torn down for rebuilding, also went into these dams, along with masses of stone from other wrecked buildings in the Crescent City.

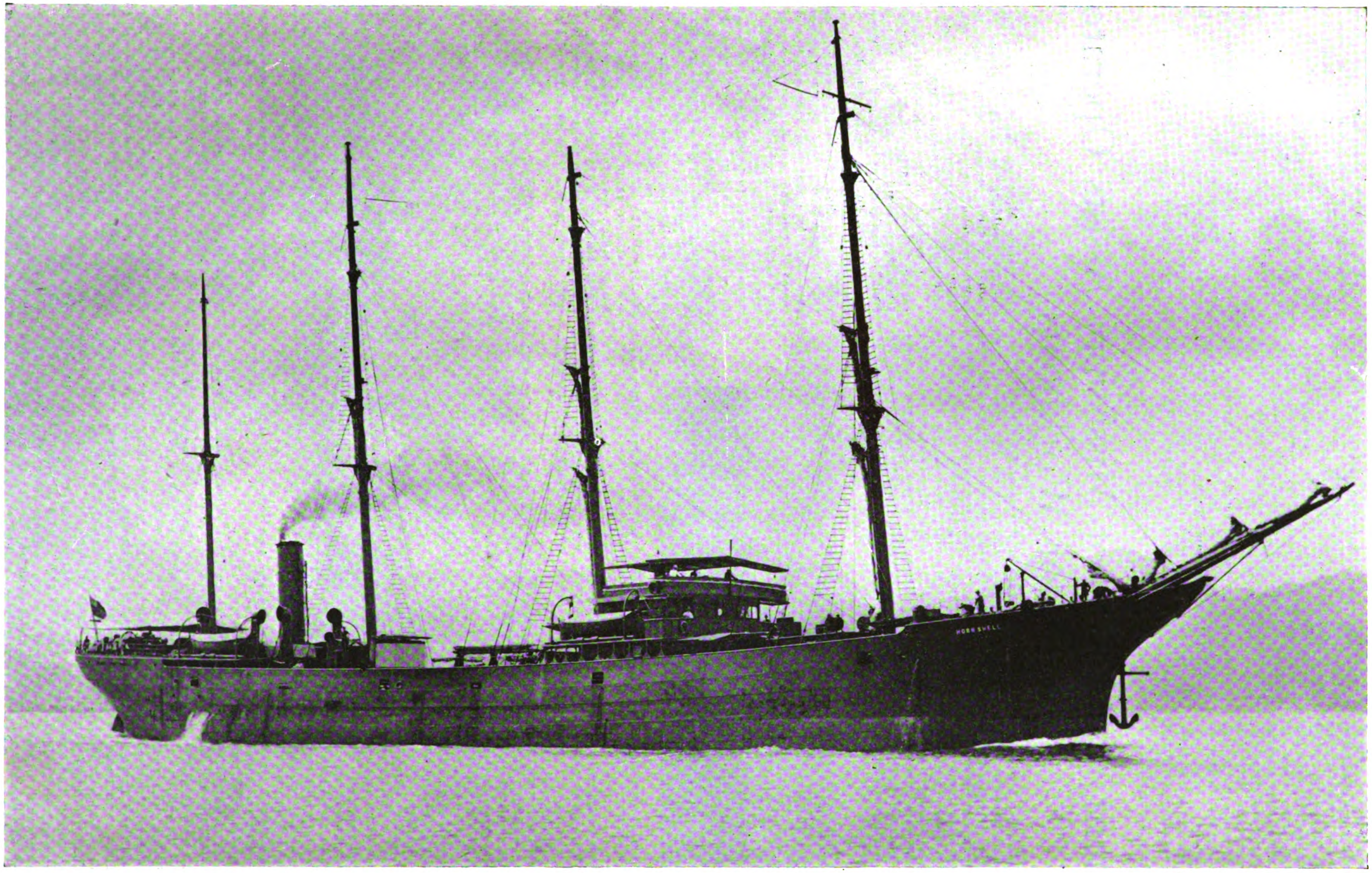
The making of the willow mattresses is interesting. Great barge-loads of green willow trees, from twenty to forty feet high were cut from the banks of the river and the inland swamps and brought to the mattress-making barge, willow being selected because it will endure almost indefinitely when completely covered with water. On the main barge these willow trees were bound into bundles about one foot in diameter, with hoops of iron, and then laid on a warp of quarter-inch steel wires, to which they were woven tightly with a woof of wires of the same size, until they formed a great foot-thick carpet of green, in sections to suit the size of the bottom dam to be made. Most of the sections were 200x2,000 feet, but some ranged down as small as 200x500 feet.

As fast as this mattress was woven, it was reeled off the barge into the water at the point where it was to lie, the barge moving ahead slowly all the time. Then, behind the end of the mattress came other barges, laden with stone, which was spread evenly over this mattress, sinking it to the bottom in the place desired. When the proper amount of mattress had been made, the mattress-making barge turned back, and laid another layer over the stone which had been dropped on the first, and so on until the dam was of the height required.



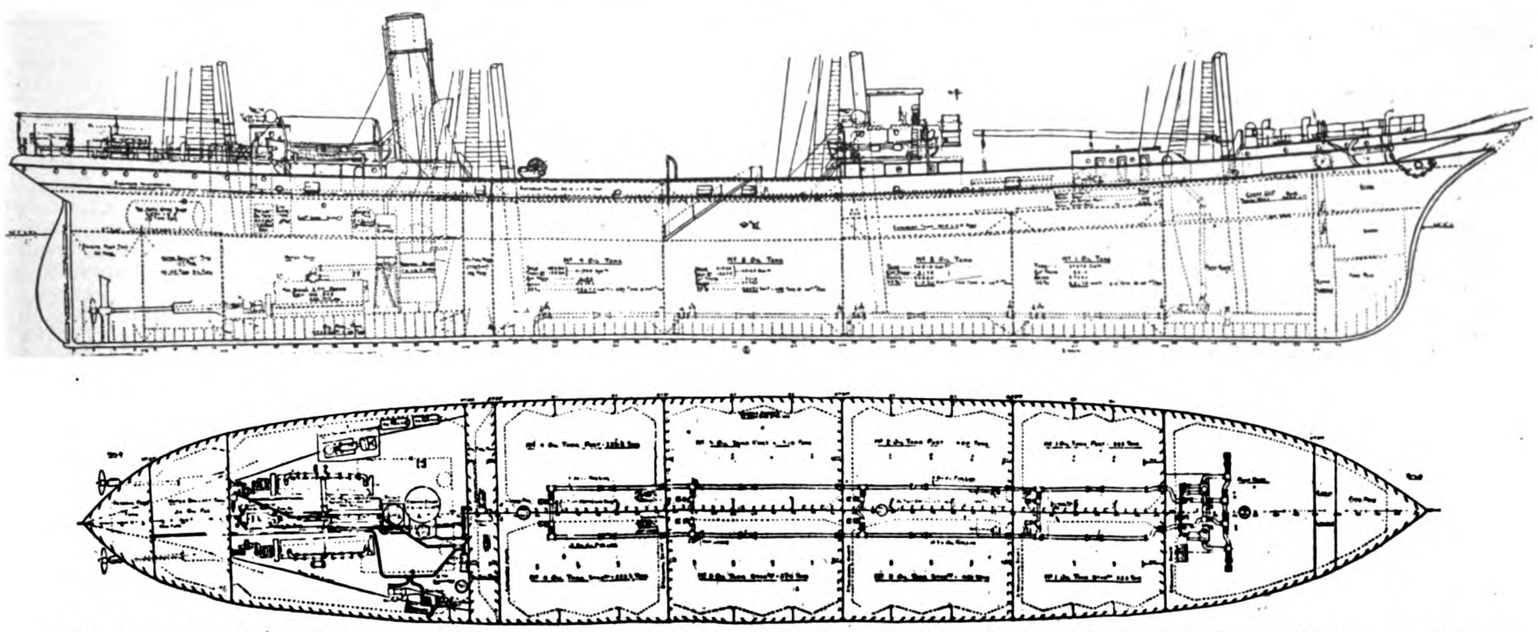
Driving the sixty-foot piling which makes up the "water-fence" holding the Mississippi's torrent within bounds

This cutting off of the other mouths of the Mississippi sent the full force of the current down Southwest Pass, resulting in the stream cleaning its own channel between the new breakwaters, and maintaining there a perpetual depth of 35 feet, except behind the wing dams, which the dredge will have to keep clean. More than this, the straight deep channel now afforded will save about two hours in the time of the average freight steamer from the mouth of the river to New Orleans, which is 110 miles upstream from the jetties. It will save even more time for the large working motorboats which have business on the gulf and for the auxiliaries which are engaged in service between New Orleans and the ports of Latin-America and of the Islands of the Carribbean Sea.



FROM SAIL TO ECONOMICAL MOTOR POWER

The motorship "HORN SHELL." During the emergency of the war the British converted many old iron and steel sailing-ships into full-powered Diesel-driven bulk-oil carriers, and thus partly relieved the tanker shortage In order that this could be rapidly done, submarine engines were diverted and used for the purpose, and the "HORN SHELL" is one of eight ships thus converted, work on a similar number being stopped on the signing of the armistice. No fewer than 20 British shipyards and engineering works were engaged in building these Diesel engines from the same drawings, so large numbers were completed. The "HORN SHELL" is owned by the Anglo-Saxon Petroleum Company of London and is propelled by two 800 shaft H.P. Vickers solid-injection "Diesel" engines. The work of conversion was carried out by the Hong Kong and Whampoa Dock Co., Ltd., Hong Kong.



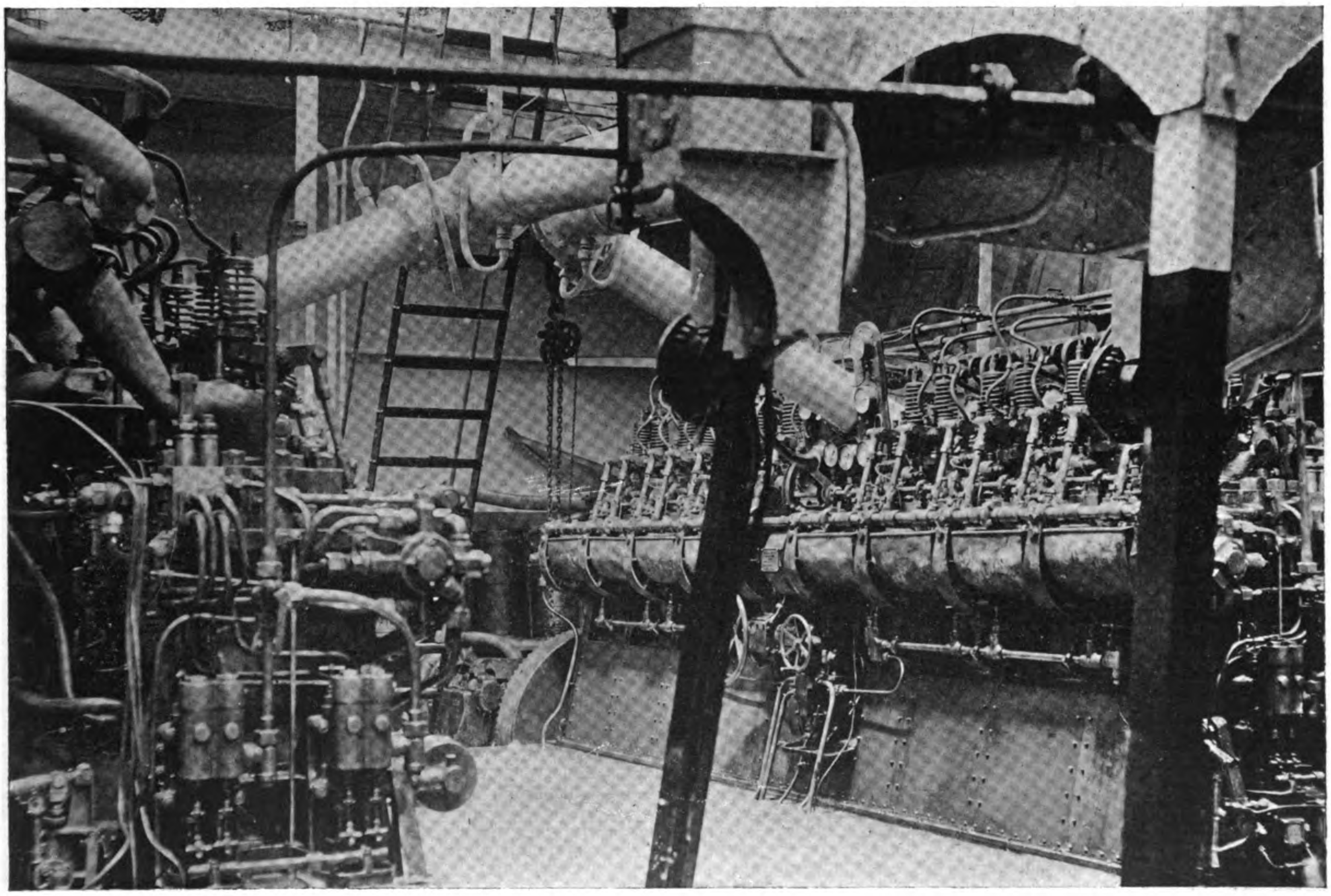
The tanker "Circe Shell," 4,000 tons d.w.c. fitted with two 630 shaft h. p. Vickers "Diesel" propelling engines and steam auxiliaries

Converting Sailing-Vessels to Full-Powered Motorships

A Fleet of Tankers Fitted with Vickers Solid-Injection Type "Diesel" Engines

SEVERAL times we have referred in the columns of "Motorship" to the clever manner in which the British increased their oil-tanker fleet during the war by rendering antiquated tonnage up-to-date. Readers of this publication of several years ago will remember how we were the first to state that the German submarines would make a strenuous attempt to sink all oil-carrying tankers on sight. As pointed out, Germany realized if the Allied liquid-fuel supply was entirely cut-off it would only be a question of a few months before they would have obtained victory. Our readers will also remember how we urged upon the United States to build submarine-evasion type Diesel tankers, but that it took about six months before any adequate action was taken—and then they were steam powered, and this only after the British and American tanker fleet had been considerably depleted by submarine sinkings. At that time other publications were denouncing these efforts as "scare propaganda," but all "Motorship's" advance war information proved accurate.

When the submarine attacks on tankers began the Anglo-Saxon Petroleum Company of London purchased a number of iron and steel sailing-ships of fair sized tonnage and converted them to full-powered Diesel-driven vessels. They received the co-operation of the British Admiralty, who diverted a considerable number of submarine motors of high power and of which they were building a large number, and turned them over to the Anglo-Saxon Petroleum Company for installation in these sailing-ships. Altogether there were sixteen vessels, but we understand that only eight were converted up to the time of the signing of



Engine-room of the motorship "Horn Shell," showing the two 800-shaft H.P. Vickers solid-injection submarine type "Diesel" engines

the Armistice, after which the urgent necessity ceased, with the result that work on converting the remaining craft was abandoned. We have referred to these ships a number of times, but are now able to give further details.

In the ordinary way submarine-type engines are not considered suitable for large merchant craft, because of the heavy and continuous full-power loads which the machines have to stand during the long ocean voyages that tankers have to make with only a few days in port; but, under the circumstances, the results of these oil-engines in service are said to be most satisfactory, and indicated that the high-speed submarine-type Diesel engine is capable of standing harder work than is usually believed. If this is the case it means that the proposed Diesel-electric drive for merchant ships may turn out well, as high-speed engines are necessary.

After one of the ships, namely, the "Circe Shell," had covered a total of 13,486 nautical-miles, the engines were opened up for inspection and the pistons taken out, but all rings were clear of carbon, as were the piston tops and the cylinder walls. They were in good condition and only slightly worn. All the exhaust and air-inlet valves were found to be in good shape, but precaution was taken to grind the seats and valves, and the same applies to the injector-valves. After casting adrift the crankpin brasses and the crosshead brasses they were found to be in good condition. Furthermore, four bottom-brasses were taken out and examined and very little wear was noticed, nor could any wear be found on the crankshaft. Yet a number of rivets on the foundations were slack, so these were cut-out and renewed and the foundations stiffened with round stays.

The "Circe Shell" was originally known as the "Celtic Burn," and the work of converting this vessel was carried out by the Hong Kong and Whampoa Dock Yard Company, of Hong Kong, as was the work on the sister ships, "Horn Shell" and "Medway."

The "Circe Shell" had the following dimensions:

Deadweight capacity	4,075 tons
Length (B.P.)	281 ft. 9 in.
Breadth (moulded)	45 ft. 7½ in.
Depth (moulded)	27 ft. 6 in.
Power	1260 shaft h.p.
Engine speed	320 r. p. m.
Trial speed	8.75 knots at 278 r.p.m.

The rated power of each of the engines, which were built by Vickers, Ltd., is 800 shaft H.P. at 380 r.p.m., but it was decided to reduce the rating when installed in these tankers, and they were run at 320 r.p.m., at which speed an output of 630 shaft horsepower was given. The two engines together have a fuel consumption of 5.4 tons of fuel-oil per day, which is equivalent to 0.396 lb. per shaft horsepower per hour, which is almost equal to the fuel-consumption of any slow-speed engined ship afloat, regardless of the class of power. The injection of fuel was carried out at a pressure of 3,500 lbs. per square-inch, this being by cam and spring operating device, without any compressed-air, and which has been previously described in the columns of "Motorship." The pressure of the starting air was 600 pounds per square-inch. Solar-oil was used as fuel.

The motorship "Medway" has finer lines, so a better speed was obtained, namely, 9½ knots. What is remarkable is that her consumption of fuel, if the indicator readings were accurate, was 0.35 lb. per shaft h.p. hour. This consumption, if correct, is the lowest ever recorded by any merchant ship afloat. It may be suggested that her engines were not actually producing this power. But, we have to remember that in the latter case it is hardly likely that the ship would have made 9½ knots, which is better than the trial speed. In the "Medway" two Vickers solid-injection Diesel-engines of 630 shaft h.p. were installed. The vessel has the following dimensions:

Length	330 ft.
Breadth	43 ft. 2 in.
Depth	26 ft. 6 in.
Deadweight capacity	4000 tons
Power	1260 shaft h.p.
Engine speed	280 r.p.m.
Ship's speed	9½ knots

On trials a speed of 9.187 knots at 281 r.p.m. was obtained, but on her maiden voyage from Hong Kong to Balik Papan she averaged 9.5 knots, covering the distance in 1,175 hours and 15 minutes. The lubricating-oil consumption was 30 gallons per day. This is rather high for engines of this horsepower, but is, of course, due to their high speed. The lubricating-oil pressure was 16 lbs. Fuel-injection pressure was 3,500 lbs., the cooling-water temperature maintained around the outlet was 83 degrees F.

While through the courtesy of the Hong Kong & Whampoa Dock Yard Company we are able to publish some excellent photographs of the "Horn Shell," we have no information regarding this vessel or her operations nor have we of the "Fenia," which was another of the ships converted.

About the same time Alex. Stevens & Son, Ltd., of Glasgow, converted the sailing-vessel "Oweenee" into a full-powered motorship for the same owners. In carrying out the work of conversion the question of sub-division of the vessel arose in order to fix the position of the various bulkheads so that the maximum quantity of oil could be carried with the ship in proper trim. The builders and owners decided that this result could best be obtained by constructing four oil-tanks with the pump-room forward of the foremost tank, and the expansion tanks underneath the decks.

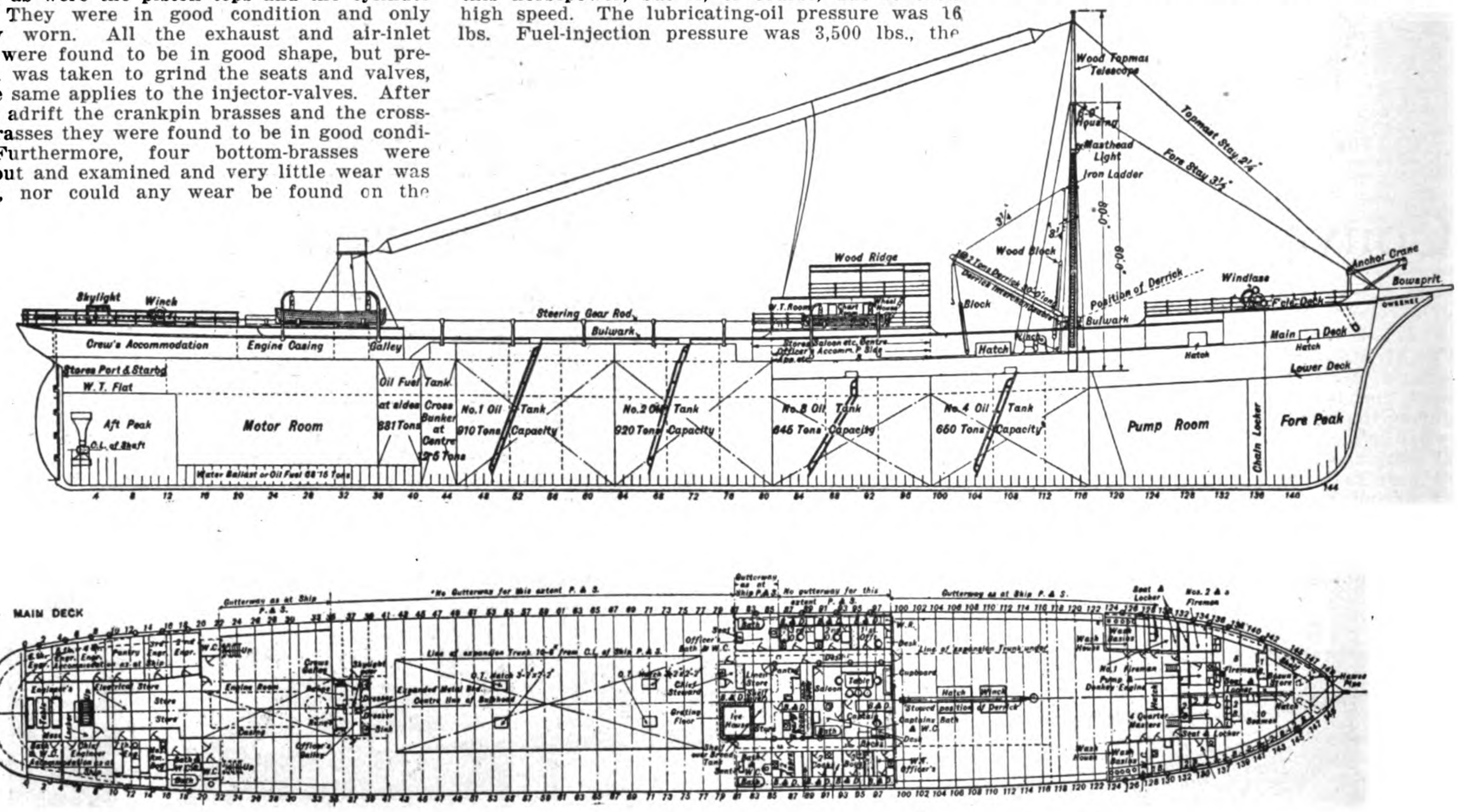
Although the deadweight capacity of this vessel after conversion is 3,659 tons, she is able to carry no less than 3,300 tons of bulk-cargo, only 350 tons being needed for bunkers and stores. This vessel proved to be one of the fastest of the fleet, although her horsepower is the same as the other ships. On trials a speed of 10.44 knots was obtained, while on her maiden voyage from the Clyde to Port Said she averaged 9.88 knots on a daily consumption of 4½ tons of oil fuel. This, of course, is a very excellent showing for a vessel of her size and power, and gives a comprehensive indication of how sailing-ships can be made practicable when converted and equipped with adequate power. "Motorship" has frequently indicated that the fault of the sailing-vessels and many full-powered ships built in the United States has been under-powering, resulting in dissatisfaction for everyone concerned.

The "Oweenee" has the following dimensions:

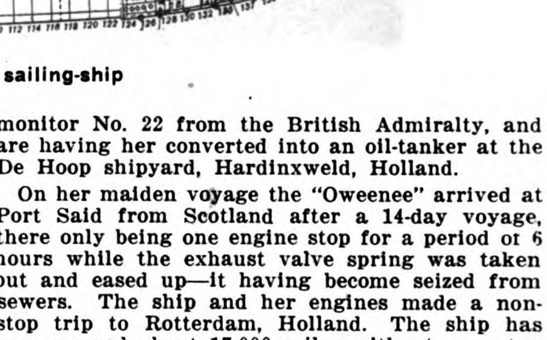
Length	309 ft.
Breadth	40 ft.
Depth	24 ft. 6 in.
Power	1260 shaft h.p.
Engine speed	320 r.p.m.
Deadweight capacity	3650 tons
Daily fuel consumption	4½ tons

As in the case of the others, and as previously mentioned, she is propelled by twin eight-cylinder Vickers four-stroke solid-injection Diesel engines, each adjusted to give 630 shaft h.p. at 320 r.p.m. Before conversion the "Oweenee" was a four-masted bark. New deckhouses were erected amidships along each side with the Captain's accommodations and store-rooms in the center. On the deck above these accommodations was placed the wireless-room, chart-room and navigating bridge, and on top of this again is a flying-bridge. There is only one mast, and this is stepped forward, and is used for carrying the wireless aerials, the other end of the aerials being connected to the exhaust stack aft. It is of interest to remark that the Anglo-Saxon Petroleum Co. recently purchased the monitor No. 22 from the British Admiralty, and are having her converted into an oil-tanker at the De Hoop shipyard, Hardinxweld, Holland.

On her maiden voyage the "Oweenee" arrived at Port Said from Scotland after a 14-day voyage, there only being one engine stop for a period of 6 hours while the exhaust valve spring was taken out and eased up—it having become seized from sewers. The ship and her engines made a non-stop trip to Rotterdam, Holland. The ship has now covered about 17,000 miles without any stop at sea or delay at port, altho her engines are of the high speed submarine type. The fuel valves are cleaned and ground about every 20 days. Lubricating oil consumption is 15 gallons per day.



The Vickers "Diesel"-driven tanker "Oweenee," converted from a sailing-ship



Fairbanks-Morse auxiliary pumping set in the engine-room of the "Trolltind"

Merchant Motorships with Sulzer Two-Cycle Diesel Engines in Service or Building

(Installations from 100 to 4,000 shaft h.p.)

Type of vessel	Names of boats, or of owners' country	Shaft H.P. of engines	Number of propellers	Tonnage
Cargo ships of 5000 tons and upwards	"Sabara" ex "Monte Penedo"	1700	2	6500
Cargo ships of 5000 tons and upwards	Ship No. 623	4020	2	9000
Cargo ships of 5000 tons and upwards	"Zamora"	800	1	6000
Cargo ships of 5000 tons and upwards	Sweden	800	1	5500
Cargo ships of 5000 tons and upwards	Sweden	2500	2	8000
Cargo ships of 5000 tons and upwards	Sweden	2500	2	8000
Cargo ships of 5000 tons and upwards	Norway	3300	2	9000
Tank ship	England	3200	2	
Tank ship	"Demosphen"	440	2	
Tank ship	England	165	1	
Tank ship	England	200	2	
Tank ship	England	1640	2	
Tank ship	England	900	2	
Tank ship	"K. W. Hagelin"	1540	2	
Tank ship	England	2700	2	
Cargo ships of 1000 to 5000 tons	"Ljuboff"	840	2	1600
Cargo ships of 1000 to 5000 tons	"Isonzo"	840	2	
Cargo ships of 1000 to 5000 tons	Italy	840	2	
Cargo ships of 1000 to 5000 tons	Italy	840	2	
Cargo ships of 1000 to 5000 tons	Italy	840	2	
Cargo ships of 1000 to 5000 tons	Brazil	840	2	
Cargo ships of 1000 to 5000 tons	Italy	840	2	
Cargo ships of 1000 to 5000 tons	Italy	840	2	
Cargo ships of 1000 to 5000 tons	Italy	840	2	
Cargo ships of 500 to 1000 tons	England	640	2	850
Cargo ships of 500 to 1000 tons	"No. 102"	420	1	
Cargo ships of 500 to 1000 tons	"No. 103"	420	1	
Cargo ships of 500 to 1000 tons	France	420	1	
Cargo ships of 500 to 1000 tons	France	420	1	
Cargo ships of 500 to 1000 tons	France	420	1	
Cargo ships of 500 to 1000 tons	France	420	1	
Cargo ships of 500 to 1000 tons	France	420	1	
Cargo ships of 500 to 1000 tons	France	420	1	
Cargo ships of 500 to 1000 tons	Germany	420	1	
Cargo ships of 500 to 1000 tons	Germany	420	1	
Cargo ships of 500 to 1000 tons	Germany	420	1	
Sailing ships	"Aquila"	100	1	500
Sailing ships	"Itamaraca"	580	2	2500
Sailing ships	Brazil	420	1	3300
Sailing ships	"Italia"	420	1	3300
Sailing ships	"Po"	600	2	3150
Sailing ships	"Clémenceau"	420	1	1500
Boats for coasting and river trade	"M. B. 6"	100	1	
Boats for coasting and river trade	"Oltenitza"	100	1	
Boats for coasting and river trade	"Romagna"	690	2	
Boats for coasting and river trade	"Elbe I"	290	1	
Boats for coasting and river trade	"Uto"	160	1	
Boats for coasting and river trade	"Solvay I"	300	2	
Boats for coasting and river trade	"Saetta"	200	2	
Boats for coasting and river trade	"Folgore"	200	2	
Boats for coasting and river trade	"Irun"	400	1	
Boats for coasting and river trade	"Diligente"	840	2	
Boats for coasting and river trade	Rumania	840	2	
Boats for coasting and river trade	"Bouffonne"	840	2	
Boats for coasting and river trade	Rumania	840	2	
Boats for coasting and river trade	"Surveillante"	840	2	
Boats for coasting and river trade	"Engageante"	840	2	
Boats for coasting and river trade	Rumania	840	2	
Boats for coasting and river trade	Rumania	840	2	
Boats for coasting and river trade	"Eole"	440	2	
Boats for coasting and river trade	"Mathurin"	420	1	
Boats for coasting and river trade	"Troupier"	420	1	
Boats for coasting and river trade	"Conquérante"	1800	2	
Boats for coasting and river trade	"Vaillante"	1800	2	
Boats for coasting and river trade	"Caribou"	650	2	
Boats for coasting and river trade	"Onagre"	650	2	
Tug boat	"No. 19"	100	1	
Tug boat	"No. 21"	100	1	
Tug boat	"Fortschritt"	150	1	
Tug boat	"Peer Allagi"	400	1	
Tug boat	"Yokosuka Maru"	620	2	
Tug boat	"Cuzavoda"	180	1	
Tug boat	"No. 50"	165	1	
Tug boat	"Morin"	420	1	
Tug boat	"Nive"	420	1	
Tug boat	"Scorff"	420	1	
Tug boat	"Touques"	420	1	
Tug boat	"Trieux"	420	1	
Tug boat	"Vendée"	420	1	
Tug boat	"Ill"	420	1	
Tug boat	"Sarre"	420	1	
Tug boat	"Léman"	420	1	
Tug boat	"Bourget 3"	420	1	
Total	83 vessels	63,020 shaft h.p.	125 engines	

In addition to the above, Sulzers have delivered for naval purposes 49 engines totaling 65,000 I.H.P., without those constructed by their licensees.

TWO-CYCLE DIESEL MARINE ENGINES have been constructed, or are in course of construction, to date TOTALING MORE THAN 300,000 INDICATED HORSE POWER.

OLD SAILING-SHIP CONVERTED

J. H. Laing of Halifax, has had his old schooner "Madonna", built in 1892, fitted with a Fairbanks-Morse oil-engine for auxiliary power.

NEW DUTCH 1,000 TONS MOTORSHIP

A motorship of 1,000 tons gross has been launched at the Nicolaas Witsen Shipyard (W. F. Stoll & Son), Alkmaar, Holland.

NEW CHINESE OIL ENGINE COMPANY

A new engineering company known as the Wai Po Engineering Works has been formed in Canton by Mr. W. P. Loo, who recently graduated from the Massachusetts Institute of Technology at Boston. Among other things the company will build marine crude oil engines and the capital is two hundred thousand dollars.

THE BJORNEBORG OIL ENGINE

A four-cylinder oil-engine built by the Bjorneborgs Mek Verkstad, of Bjorneborg, has been installed in the 147-tons gross auxiliary-schooner "Inkeri" owned by J. Nurminen, of Faumo, Finland.

NEW DANISH AUXILIARY

"Danedvanning," a new four-masted auxiliary schooner, has been launched at the Rodby shipyard, Rodby, Denmark, to the order of the Oceana Steamship Co. of Copenhagen. Two 160 shaft h.p. oil-engines are installed. The vessel is 242 ft. 2 in. long by 40 ft. breadth.

NEWFOUNDLAND AUXILIARY

The new wooden auxiliary schooner "Sordello" 582 tons is powered with a Skandia heavy-oil engine. She is owned, and was built by, the Anglo-Newfoundland Development Co. & A. Reed Co., St. Johns, Newfoundland.

NEWFOUNDLAND AUXILIARY SCHOONER "DOBBIE"

In the wooden three-masted auxiliary schooner "Dobbie" owned by J. O. & A. Williams, St. Johns, Newfoundland, a three-cylinder Mietz oil-engine has been installed. The vessel was built by D. Pelley at Pt. Blandford in 1918.

MOTORSHIPS IN MEXICO

Messrs. Manuel Angel Fernandez & Co. have appointed Messrs. Seabury & De Zafra, Inc. of New York, as their consulting engineers and naval architects in connection with their rapidly developing line of freight-vessels operating along the East coast of Mexico in conjunction with the Ward Line. Mr. Manuel Angel Fernandez is president of the company and has for many years been a keen reader of "Motorship," he being numbered among our oldest subscribers. He is greatly interested in motor vessels.

FRANCO-TOSI DIESEL-ENGINE PRODUCTIONS

Up to the 31st of March, 1920, the firm of Franco-Tosi of Legnano had completed 844 stationary Diesel-engines of the two and four-cycle types, aggregating 119,526 shaft h. p. Altogether these engines consisted of 1,776 single-acting cylinders, and in addition they have completed 63 marine Diesel-engines of the two and four-cycle type, aggregating 27,350 h. p., consisting of 337 single-acting cylinders.

If we take the value of these engines as averaging $100.00 per shaft h. p. it means that the total value of the marine and stationary Diesel engines completed by Franco-Tosi amounts to $146,876,000.00.

We have just received from Messrs. Franco-Tosi a copy of their new Diesel-engine catalogue which, in addition to containing illustrations and details of their varous types of Diesel-engines, contains a complete list of every marine and stationary engine which they have constructed.

Hydraulic Propulsion for Ships

Possibility of Its Adoption in Conjunction with Diesel Engines—Views Formed by Recent Experiments

By D. V. HOTCHKISS, A.M.I.N.A.

It is perhaps not surprising that the so-called "Hydraulic Propeller," by which is meant an internal propelling-device, has been ruled out as a possible competitor to the ordinary screw or paddle by the majority of practical marine-engineers. The history of the attempts which have been made to evolve a successful device of this kind is sufficiently discouraging to warrant the skepticism which exists as to its ultimate usefulness. Whilst this attitude of skepticism is perfectly justifiable in the light of past experience, it is at the same time questionable whether the attempts of the past have even proved the hydraulic propulsion theory to be unsound.

In this article the author will attempt to show that whether the hydraulic propeller may be relegated to the scrap heap or not, its failure in the past is in every case traceable to simple faults, some of which could have been rectified, and not, as generally supposed, to inherent fundamental misconceptions of the general problem of propulsion.

The large number of serious attempts to solve the problem of hydraulic propulsion testify to the advantages to be gained should such a form of propeller become a practical proposition, and the inducements which led to the attempts of the past are increased rather than diminished by the advent of the geared-turbine and the economical internal-combustion heavy-oil engine. Of these, in the former we have an engine which can accommodate its revolution speed over a wide range, and in the latter, a prime-mover whose natural revolution speed ranges above that of reciprocating steam-engines of equal power, and whose performance, in conjunction with the screw-propeller, is considered by many to be somewhat handicapped thereby.

A resume of the fundamentals of propulsion is necessary if the argument is to be grasped without reference to the text books.

Speaking broadly, a ship may be regarded as a stream-line body, the surface being disposed so that the laws governing the resistance of solids moving through fluids shall be obeyed. Through this carefully maintained formation of stream-lines and varying pressures a "hole" is punched by the propeller stream or streams.

Experience has shown that different positions for propellers have varying merits in proportion to the degree of interference sustained by the pressure formation around the ship. It has been established also that the present normal position of the propeller is fixed rather by mechanical considerations than by scientific reasoning, since it is generally found that the action of the screw is detrimental rather than beneficial to the ship's normal stream-line action or hull efficiency.

While the screw-propeller can barely be fitted in any position other than the stern or near the stern of a ship, it is impossible, as things are, to recover any large measure of the so called "thrust deduction" unless some propeller can be devised to work in a new and hitherto untried position. It is a curious fact that from the point of view of streamline action the stern-wheel is placed in the worst conceivable position, side-paddles being a little better, but by no means well placed, whilst the screw rarely helps and generally hinders the streamline formations, the principal integument of the thrust deduction being the reduction of hydrostatic-pressure at the quarters of the vessel prow, whence the propeller draws its supply of feed-water.

There is a strong need for research in the matter of propulsion when regarded along lines such as these, for it is not too optimistic to hope that a large part of the present energy loss of the slip streams may in the future be recovered whilst at the same time the thrust deduction is reduced.

As regards the local action of any form of propelling apparatus, the formula $\frac{WS}{G}$ = thrust (lbs.) is, of course, the fundamental, where W = weight acted upon per second, S = extra velocity imparted to it, and G = the accelerating force of gravity, say 32.2. S is kept as low as possible to avoid the inevitable loss of energy in the slip stream.

The application of these first principles results in the screw-propeller being made of such size that very low slips are realized, and this is made possible by the design of hull and also of the prime mover, which are, so to speak, built around the propeller, to whose requirements both are ultimately subservient. An hydraulic-propeller, before it can overcome prejudice, must, amongst other trials, be able to propel a hull intended for screw propulsion, and generally with the aid of engines, which, if built especially for it, are generally of an experimental nature.

If the screw-propeller may be regarded as a pump or accelerator, it is reasonable to criticize its performance in the following terms. Taking the mean speed in a sternward direction of the accelerated column of water we have, to commence, the fundamental loss due to the energy of the slip stream expressed by the formula Jet efficiency $= \frac{V}{\frac{V+S}{2}}$ where V = speed of ship in feet per sec. S = acceleration. Thus, 25% slip represents a loss of about 11% of the work done by the propeller on the water.

A propeller which gave an overall thrust-efficiency of 65% with a slip of 25% would be considered as a pump, working at 73% efficiency. Supposing the slip to be only 15%, then the jet loss would be about 8%, and the punch efficiency roughly 71%. These are normal figures, but if the case of a special propeller is taken, *assuming* the overall efficiency to reach 75%, then taking the most advantageous slip for the purpose of arriving at the highest possible punch efficiency, we get, with 25% slip, Jet efficiency = 89% and punch efficiency = 84%. It must be admitted that the average good performance of the screw-propeller regarded as a pump lies nearer to the figure 71% than to the latter 84%, and this leads us to the question of the fundamental soundness of the hydraulic-propulsion proposition.

More than one firm of centrifugal-pump manufacturers claim an efficiency of 90% for their pumps under certain conditions. These conditions, however, are generally such that the water is passed into the pump at very low velocity and not, as in the case of a propeller, sometimes at extremely high velocity, i. e., the velocity of the ship relative to the water through which it is passing. On the other hand, since the need for pumps of the accelerator type has not been general, comparatively few have attempted to solve the problem.

Many designers of hydraulic propellers have realized the necessity for taking full advantage of this relative motion of the water to the ship, and the most practical forms of apparatus, so far, to meet the case, have been the many different types of screw pumps evolved from time to time and dating back to Ruthvin's hydraulic propeller.

One of the most successful attempts at hydraulic propulsion was that of the French barge "Nautilus" some 10 years ago, in which was installed a Maginott's screw-pump driven by a single cylinder vertical steam-engine. This installation, although working with a jet efficiency of only 66.6% or 100% slip attained an overall propulsive coefficient of about 37%, the pump giving an efficiency of 84%.

It would seem, therefore, that in this case, if the size of the apparatus could have been increased, a much higher overall efficiency would have been realized. This, however, brings us to a consideration of the difficulties to be met with on account of size and weight. It is safe to assert that no form of hydraulic-propeller employing piping in the ordinary sense of the word, to convey the water to and from the pump or pumps can hope to deal with the very large quantity which is required to produce the reaction required without imparting excessive velocity in the form of wasteful slip. In any such form of apparatus there must be excessive weight and bulk, and, in addition, a large amount of frictional loss.

Secondly, any system depending upon a form of pump in which there are conversions from velocity-head to pressure-head and a trial re-conversion to velocity at the jets will fail to compete with the screw-propeller or paddle.

Lastly, the only change of direction permissible during the passage of the water through the complete system is a simple change from motion in a straight line to rotational motion and vice versa.

The screw-propeller depends in its pumping action upon the formation of a vortex which takes the place of the metal casing and guide blades of the screw-pump. When the propeller is placed in sufficiently close proximity to any solid substance, such as the ship's hull or a partial tunnel therein, the vortex breaks up and inefficiency is the result. It is possible, however, that the vortex principle may be applied in ways more convenient than obtained in the screw-propeller, and along these lines the hydraulic propeller, if it ever matures, will probably develop.

Assuming, therefore, that a pump could be produced which would give 85% efficiency whilst accelerating water from the velocity of intake (say 15 knots or 25.33 feet per second) to the velocity of discharge 25% in excess of this, the performance would work out at jet efficiency 89%, pump efficiency 85%, propeller efficiency 75.65%, with 50% slip, which brings the matter down to a possibility as regards size and weight, the total efficiency, as a propeller, would be: Pump, 85%; jet, 80%; propeller, 68%. From the *screw*-propeller of this efficiency must be deducted the thrust-block and shafting friction, which is generally in the neighborhood of 8%, or even 10%, and also the thrust deduction, which is variable, but may be taken as 5%.

These figures, which are admittedly based upon the performance of a pump which does not, to the writer's knowledge, exist, should be, nevertheless, an inducement to further research, since whilst hypothetical, they are not fantastic and will possibly be realized in the near future.

Regarding the important advantages to be gained in the event of a hydraulic system of propulsion taking the place of the screw-propeller, the following should be sufficient to form an inducement to effort on the part of naval-architects and hydraulic-engineers.

Hydraulic systems have been evolved which have been absolutely free from all vibration. Steering by means of jets as a reserve steering-gear to the more usual type has been tested experimentally and found to have great possibilities. Maneuvering can be carried out by means of jets to a much greater extent than is possible with twin screws and rudder. Lastly, there is no need in a hydraulic system for a long line of shafting or for any increase in draught over that required by the hull for hydrostatic reasons, the thrust, moreover, can be taken up by the impeller hydraulically.

These advantages are only a few of the excellent features easily within reach of the hydraulic propeller. It remains for engineers to tackle the question in a new spirit and to evolve a pump to meet the special requirements outlined.

OUR IMPORTANT ANNOUNCEMENT

In our June issue (page 508) we referred to an announcement which we would make concerning the arrangements for a big American motorship fleet to be built. This announcement will be made in the September issue of "Motorship" unless anything happens to affect the negotiations now practically completed.

BRITISH GOVERNMENT SELLS DIESEL ENGINES

Four Merchant-ship type Sulzer Diesel-engines of 1750 s.h.p. at 110 R.P.M. were offered for sale by public tender by the British Ministry of Munitions on July 17th. On the same day four merchant-ship Diesel-engines of the same make, but developing 750 s.h.p. at 160 R.P.M. were also offered for disposal by the Ministry of Munitions.

"MOTORSHIP" BOUND VOLUME FOR 1917 WANTED

The free library of Philadelphia is very anxious to possess a complete file of "Motorship", and is desirous of obtaining the volume for the year 1917, either bound or unbound. Readers of "Motorship" who have such a volume for sale are requested to communicate with the Mutual Subscription Agency, 602 Crozier Building, Philadelphia. Pa.

We also understand that the Philadelphia Free Library is desirous of purchasing a complete set of unbound numbers of "Motorship" for the year 1919. Readers who have such a set for disposal should communicate with the Mutual Subscription Agency.

Our Readers' Opinions

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed

FOUR-CYCLE VERSUS TWO-CYCLE DIESEL ENGINES

To the Editor of "Motorship":

Sir:—In the May number of "Motorship" Mr. J. C. Shaw, of the William Cramp & Sons Ship & Engine Building Co., expresses his views on the article entitled "Sulzer Two-Cycle Engines and the Propulsion of Cargo Boats" which appeared in the March and April numbers. We are very glad that the representative of a firm building four-cycle engines should give his opinion: only in this way is it possible to arrive at any definite conclusion as to the advantages and disadvantages of the two systems, and above all to remove erroneous ideas.

We do not share Mr. Shaw's opinion as to the undesirability of opening up the old controversy of the two-cycle versus the four-cycle engine. On the contrary we think that, correspondingly as the two types of engine are developed and improved, it will always be necessary to compare them again until it is finally recognized which type is the better suited for any particular purpose.

As we construct four-cycle Diesel engines as well as two-cycle—our total output to date represents more than 900,000 I.H.P., divided practically equally between four-cycle and two-cycle—we have had the benefit of many years' experience in both systems. And, right from the beginning we have always been perfectly free to take up whichever type we preferred, and have never been forced in any way to any one system, so that Mr. Shaw must acknowledge that we have our special and definite reasons for preferring the two-cycle engine for ship propulsion.

Mr. Shaw discusses the following points in his letter:

1. Mean indicated-pressure;
2. Revolutions per minute;
3. Weight of the engines;
4. Dimensions of the engines.

(1). *Mean indicated-pressure.* Mr. Shaw's assumption that the M.I.P. in the two-cycle engine must not be more than two-thirds that in the four-cycle is not correct. The M.I.P. for our two-cycle engine at normal load is 6.5 to 6.8 atmospheres. That other makes of two-cycle engines cannot be worked at such pressures is of no importance here, as Mr. Shaw is criticizing our two-cycle engine and no other. The M.I.P. for a four-cycle engine is about 6.3 atmospheres, which Mr. Shaw considers good practice and says it should not be exceeded in order to avoid heat troubles.

With regard to the difference between our two-cycle engine and the two-cycle engine of other makers, special reference must be made to the simplicity of design of the cylinder-head in our engines, where the strains due to heat transmission through the cylinder-head walls are reduced to a minimum. The cylinder-head of our two-cycle engine has only one relatively small opening, and that exactly in the centre, and differs in this respect not only from the four-cycle heads in use up to now, but also from the two-cycle cylinder-heads in other makers' engines.

(2). *Revolutions per minute.* Mr. Shaw's observation that the number of revolutions for the two-cycle engine is limited in order to keep the scavenging-pressure low, almost makes one think that he is trying to lead the reader's judgment astray. It is evident that the two-cycle engine, just as well as the four-cycle engine, can be worked at a higher speed than that given in our article. In fact this is the case in all the large two-cycle engines of which we have constructed over 70 to 1000 to 4000 B.H.P. The revolutions of these engines lie between 115 and 170 per minute. The special design of our two-cycle engine, with its scavenging through ports in the cylinder-walls, enables a large scavenging area to be obtained, and the scavenging-air consequently enters the cylinder at the minimum of pressure and under the most efficient scavenging conditions, even when the number of revolutions is high. The number of revolutions per minute chosen for the examples in our article was intentionally taken low at 85, because we believe it better to make the revolutions for motorships the same as is usual in steamers, so that the propeller efficiencies for the two methods of working are the same.

(3). *Weight of the engines.* When the weights given by Mr. Shaw for four-cycle engines with the high speed of 135 R.P.M. are converted into the weights for low-speed engines of about 85 R.P.M., it is at once seen that the weights given by us are perfectly correct. It is also obvious that an engine whose cylinders have only half the volume of those of another engine, will be only about half as heavy as that engine.

(4). *Dimensions of the engines.* The sections of a Sulzer two-cycle engine cylinder and of a four-cycle engine cylinder given in our article (on page 210) are shown in correct proportion, if the same effective work is done in each cylinder. The same scale has of course been chosen for both types of engine.

Mr. Shaw constructs a comparative table from his own data, and at the same time assumes that the four-cylinder two-cycle engines in our article with cylinders of 680 mm bore and 1100 mm stroke, develop only 2700 I.H.P. instead of 4050 I.H.P. The data thus obtained he then compares with the data for two six-cylinder four-cycle engines developing only a total of 2700 I.H.P., and, in order to make the difference still more favorable to the four-cycle engine, Mr. Shaw makes it run at 135 R.P.M. but the two-cycle engine only at 85. In reality therefore, he compares two high-speed four-cycle engines developing a total of 2050 B.H.P. with two low speed two-cycle engines developing a total of 3200 B.H.P.

Mr. Shaw may be absolutely certain that the figures given in our article for dimensions, horsepower and weight of machinery are not merely the creations of our fancy, and that we answer for their accuracy. Similarly we presume that Mr. Shaw's figures for the dimensions and weight of a 2700 I.H.P. four-cycle installation are correct ("Total weight of installation including shafting and propellers 594 tons"). But now, if this four-cycle installation is to develop the same brake horse-power as the two-cycle installation (i.e. 3200 B.H.P.), the figures become distinctly unfavorable for Mr. Shaw's argument; the revolutions of the four-cycle engines being kept at 135 per minute, the cylinder volumes must be in this case increased in the proportion of 3200:2050, i.e. must be 1.56 times greater, and if the revolutions be decreased in order to make the two installations the same in this respect, the cylinder volumes must be still further increased, and become 3200/2050 x 135/85 =2.5 times greater than that of the 2700 I.H.P. four-cycle installation selected by Mr. Shaw.

Now everyone connected with Diesel-engine construction knows that the weights of the engines, and therefore also the weights of the installations, vary in proportion to the cylinder volume swept by the piston, so that the four-cycle installation comparable with a Sulzer two-cycle installation of 3200 B.H.P. must weigh (according to Mr. Shaw's figures) 594 x 2.5 tons = 1500 tons (say), which is even more than the 1344.5 tons we reckoned it at in our article and therefore proves that our comparison was absolutely fair. *We have ourselves constructed four-cycle engines representing more than* 450,000 *I. H. P.*, and are therefore quite in a position to judge the weights of such installations.

Two Sulzer four-cylinder two-cycle engines of 2050 B. H. P.. with the scavenging-pumps direct driven by the main engines, would weigh about 223 tons and the total installation about 400 tons, which is only about 68 per cent of the weight of 594 tons given by Mr. Shaw for a four-cycle installation of the same output, i.e. about 2700 I.H.P.

Mr. Shaw concludes his letter with a comparison of the performances of the two motorships "Sabara" and "Suecia," the former fitted with Sulzer two-cycle engines and the latter a four-cycle engined ship, and the result is apparently so favorable to the four-cycle ship that Mr. Shaw says, "Comments on the above performances are hardly necessary." Whether it is really the case or not that, as you remark at the end of Mr. Shaw's letter, a naval-college student was made a chief-engineer on the two-cycle boat because he had read books on Diesel-engines.

What is of much more importance is the fact that, while the ship was lying in the harbor of Rio de Janeiro the German crew rendered the engines useless by breaking up and otherwise damaging sundry essential parts of the machinery. The ship then lay unattended for a considerable time, until set to work again with an engineering-staff quite inexperienced in the working of Diesel engines. It could hardly be expected, under these circumstances, that the engines could give the same result as they would have done under a crew thoroughly acquainted with them.

In the above we have given merely a few facts concerning the two-cycle engine, sufficient to prove the errors underlying Mr. Shaw's misleading statements. Besides the points he raises, there are many others which could be brought up for comparison. We should be glad if Mr. Shaw, in regard to these other points, would give us the opportunity of correcting any other erroneous ideas or impressions. Our sole wish is to see the controversy which Mr. Shaw considers as settled, or would like to have considered as settled, conducted on definite lines and founded only on proved facts. Technically the arguments have always been in favor of the two-cycle engine, and up to now experience has proved that only such arguments can decide.

We will next proceed to answer the letter of Mr. James Richardson. We are pleased that also a British engineer well acquainted with Diesel-engines should express his views on the article on Sulzer two-cycle marine engines which appeared in your March and April numbers. We thank Mr. Richardson for giving us the opportunity of learning his views on the two-cycle and four-cycle engines, and take the liberty of further elucidating the actual facts as to the real position of the Sulzer two-cycle engine. Any technical decision must be based on a consideration of such facts.

Of the various questions under discussion, Mr. Richardson refers to the following:

1. Mean indicated and effective pressures.
2. Heat transmission.
3. Weight of engines.
4. Turning moment.
5. Constructional details.
6. Auxiliary engines.
7. Propeller shafting.
8. Space occupied.
9. Fuel consumption.
10. Lubricating oil consumption.

(1). *Mean indicated and effective pressures.* Mr. Richardson recognizes that the mean effective pressure of about 70 lb. per sq. in., equal to a mean indicated pressure of about 95 lbs. per sq. in., taken by us for four-cycle engines is correct, when all auxiliaries, with the exception of the fuel-injection air-compressor, are separately driven: but Mr. Richardson knows no two-cycle engine at sea which operates continuously at more than 55 lbs. per sq. in. mean effective pressure. He thinks that with scavenging pumps driven independently of the main engines, as in the example given in our article, the mean effective-pressure must be taken at 65 and the admissible mean indicated pressure at 90 lbs. per sq. in. As mean indicated pressure for the Sulzer two-cycle engine in our article, Mr. Richardson has calculated 100 lbs. per sq. in. That is presuming the same mechanical efficiency for the four-cycle engine and the two-cycle engine with separately driven, scavenging-pumps.

In opposition to this we must point out that in the case of the four-cycle engine every working revolution is followed by a revolution during which the exhaust gases are expelled and fresh air is drawn in, operations which necessarily require some work to be done to effect them,—a small quantity perhaps, but a certain percentage. The two-cycle engine on the other hand has only working revolutions, and has, when the scavenging-pumps are separately driven, a decidedly higher mechanical efficiency than a four-cycle engine of the same power: our experiments have proved it to be about 79 to 80 per cent. If this efficiency is taken, the mean indicated pressure necessary in our two-cycle engine to give the B.H.P. mentioned, is 95 lbs.; in other words, for our two-cycle engine we have about the same mean indicated pressure which Mr. Richardson considers good and sound practice for four-cycle engines.

(2). *Heat transmission.* It is correct that the amount of heat to be passed through the cylinder walls per unit of time and combustion chamber wall area is greater for a two-cycle than for a four-cycle engine, but practice proves that it is far from being more than double the quantity.

A reader unacquainted with the real facts of the case might be influenced by such a statement. The amount of heat to be passed through the cylinder walls per unit of time and area is not the determining factor in heat transmission; but it depends principally on the form and thickness of the walls through which the heat must pass. In the first place it must be mentioned that the thickness of the cylinder walls in a two-cycle engine owing to the maximum pressure being the same but the bore smaller, is only about 75 per cent of that in a four-cycle engine of the same power. It is clear that when the walls are thinner, the cooling is more intense, as the thicker walls offer a greater resistance to the heat passing through. But, further, the form of the parts which, during combustion, are most affected, is also very important.

In this respect the inner walls of the cylinder head are more affected than any other part of the combustion chamber, while it is comparatively easy to make the piston capable of withstanding the stresses caused even by a high rate of heat transmission. The Sulzer two-cycle cylinder head has only one small opening and that exactly in the centre, and is besides absolutely symmetrical about the central axis. The four-cycle cylinder head has, on the contrary, at least four holes for valves, two of which are of very large diameter. The hot exhaust gases, as well as the cold inlet air, must also pass through the four-cycle cylinder-head.

Now, any engineer well acquainted with the problems involving a knowledge of the strength of materials, knows that the stresses occasioned in the material at the edges of the openings are three to four times as great as those in the rest of the piece, and he will at once see what the real facts are in the case of a four-cycle head with its many and large openings, quite apart from the fact that the exhaust openings are submitted to extraordinarily great stresses owing to the hot gases rushing through them. Our experience with both four and two-cycle engines has proved to us that it is easier to construct a two-cycle head capable of withstanding the heat stresses, than a four-cycle head, and this in spite of the higher rate of heat transmission as regards area of surface in the former.

(3). *Weight of the engines.* When establishing the weights given, we naturally started with the assumption that both types of engine were constructed in an exactly similar manner and with the same requirements as to structural strength. Mr. Richardson says that the weights of the engines vary proportionally to the cylinder swept volume, a view which also agrees with our experience as already mentioned in a former letter to "Motorship." The remark that submarine experience has proved that four and two-cycle engines are about equally heavy cannot be allowed as proved. The two-cycle engines compared are quite different from the Sulzer type, and for the four-cycle engines piston speeds of over 7 metres per second are attained, and the rated powers imply such high indicated pressures that they cannot possibly be considered admissible in dealing with ordinary marine engines.

(4). *Turning moment.* With regard to the turning moment, we are quite in agreement with Mr. Richardson when he says that in marine practice regularity of turning moment is not such an important point as in stationary engines. It cannot, however, be disputed, that in consquence of its more regular turning moment, the two-cycle engine requires a smaller flywheel in order to attain the same regularity of working. This gives a smaller weight of flywheel, and the engine consequently gets away quicker on being started up. This is perhaps best illustrated by the fact that it is possible to start the Sulzer four-cylinder two-cycle engine with a quite low air pressure—10 to 15 atmospheres is sufficient.

(5). *Constructional details.* In the two-cycle engine it is necessary to make the piston long enough to cover the inlet and exhaust ports in the cylinder-walls when it is at the upper dead centre. In practice, however, this has never proved to be any disadvantage. Regarding what Mr. Richardson says about the long piston in a two-cycle engine, a stuffing-box as used in the four-cycle engines could be fitted, but this has proved to be not at all necessary. It is evident that, instead of four guides, there need only be one, also in the two-cycle engine; in fact more easily than in the four-cycle engine with its stumpy piston and long piston-rod.

The starting platform is shown on the top grating in the Sulzer engine; in the four-cycle engine it is on the floor level. Of course it is possible for different opinions to be held on the question as to where is the best position for the starting levers, etc. And, in so far as this is necessary, the starting apparatus in any type of engine can be placed so that it can be operated from the floor level, or from above, or from both, as preferred. Mr. Richardson must certainly agree with us when we say that this requires only an unimportant alteration, and in any case one easily executed; therefore the weight of the total installation will not be in any way essentially affected thereby.

(6). *Auxiliary engines.* Here it must be noted, that in the Sulzer two-cycle engine no special dynamo is necessary for generating electric energy for driving the turbo scavenging-air blowers. When electric drive is employed for the auxiliary machinery on the ship, the existing electric power installation is made use of, as the turbo blowers need only be worked while at sea, and the auxiliary apparatus, i.e. winches, etc., are at work only when in port. By this arrangement, on the one hand, the effective output of the main engines is increased by the work otherwise required to drive the scavenging pumps, and, on the other hand, no special power plant is required to generate electric energy for driving the turbo blowers, for this already exists for the electric drive of the auxiliary machinery.

The reader will have noted from the data given in our article, that we have provided very ample auxiliary engines (2 x 410 B.H.P.) in the case of the two-cycle engine, as compared with those for the four-cycle (only 300 B.H.P.). We choose the auxiliary engines more than twice as powerful as they actually need be, in order to have an absolutely certain reserve. For the same reason our injection air-pump for one engine main and auxiliary, is also dimensioned so that it is sufficiently powerful to furnish the high pressure starting and injection-air required for two engines each of the same output. This ample dimensioning of the auxiliary plant, which means of course a much more reliable installation, is rendered possible by much weight being saved elsewhere in the Sulzer two-cycle marine engine.

(7). *Propeller Shafting.* The formula used in determining the size of the propeller shaft is of the form:

$$d = C \times \sqrt[3]{D^2 \times S}$$

where d = diameter of the shaft,
C = a constant, dependent on the type of engine and on the number of cylinders,
D = cylinder bore,
S = stroke.

Now, as the bore and stroke of a four-cycle engine are greater than those of a Sulzer two-cycle engine of the same power, the diameters of the propeller shafts in the examples given by us, must be in the proportion

$$\frac{d_4}{d_2} = \frac{0.4}{0.409} \sqrt[3]{\frac{(0.775)^2 \times 1.25}{(0.68\ )^2 \times 1.1}} = 1.12$$

If we now assume that the propeller shafting is the same length in both cases, the weights (G_4 & G_2) are proportional to the squares of the diameters (d_4 & d_2)

$$\text{i. e.,} \quad \frac{G_4}{G_2} = (1.12)^2 = 1.25$$

from which it follows that the difference in weight is not negligible, but is exactly as we gave it. In the case in question, the comparison is rather favorable to the four-cycle engine, and for this reason we have compared a 4-cylinder two-cycle engine with a 6-cylinder four-cycle engine. If the comparison had been made between two engines with an equal number of cylinders the result would give a propeller shaft for the four-cycle installation 50 per cent heavier than that required for the two-cycle installation. This can easily be checked by inserting the respective figures in the formulæ given in Lloyd's Register.

(8). *Space occupied.* Naturally the space required also depends somewhat on the arrangement of the main engines and the auxiliaries. In this respect again, every shipowner will have his own special wishes. The arrangement to be recommended is one in which all machines are easily accessible. In the examples given, whether four-cycle or two-cycle, consideration was given to this point. But in general the length of the engine room will depend mostly on the dimensions of the main engines. It appears therefore to be comprehensible that the six cylinders of a four-cycle engine, which are of greater bore than the four smaller cylinders of an equally powerful two-cycle engine, should require more length for the engines, and therefore also for the engine room.

(9.) *Fuel Consumption.* In marine work, it is not the amount of fuel consumed per B.H.P. which is the deciding factor; what is much more important is the relationship of fuel consumption to the total carrying capacity of the ship. In the examples we gave, it has been shown that the ship fitted with two-cycle engines has a cargo carrying capacity approximately 8 per cent greater than that of a four-cycle engined ship. From this there results such an increase in the receipts from freight in a ship of the same dimensions, that it can at once be seen that the two-cycle engined ship undoubtedly requires the smaller expenditure on fuel in proportion to the amount earned.

(10). *Lubricating-oil consumption.* We would take the opportunity of remarking here, that the fantastic figures quoted for two-cycle engine lubricating-oil consumption are quite inapplicable to the Sulzer type of engine. The consumption of lubricating-oil in a Sulzer two-cycle engine amounts to 1.5 grammes per B.H.P. hour. This figure is obtained in practice, confirmed in marine work and in power stations during several years' working, and will also be guaranteed by us.

Mr. Richardson does not deny that there is a future for the two-cycle engine, and he is right. No one who has made a close study of the subject can deny that the two-cycle engine has the most brilliant prospects, especially for large marine installations.

The Sulzer two-cycle engine gets rid of the many valves and their gearing, as the admission of air and the exhaust are controlled by the piston itself. During the working process, only one small valve in the combustion space is at work. All the other organs of control are not submitted to the high combustion temperatures. The finished weight is much smaller than that of a four-cycle engine, as also the dimensions. Great uniformity of turning moment has been attained, and the rotating masses are reduced to a minimum.

The Sulzer two-cycle engine works on the more viscous and cheaper oils, such as are used for boiler firing, and which cannot be used in the four-cycle engine on account of the lower mean temperature of the working process. The two-cycle engined ship therefore does not need to be so particular about the quality of fuel used, as a ship fitted with four-cycle engines.

Even the greatest powers can be attained by this type of engine, and dimensions still kept within reasonable limits,—limits which would exclude the possibility of constructing a four-cycle engine on account of the great dimensions required.

In addition to 450,000 I.H.P. of Sulzer four-cycle engines, the number of Sulzer two-cycle engines delivered represents a total of over 450,000 I.H.P., of which 300,000 are for marine work and over 150,000 for stationary engines, among these being some engines of 5000 I.H.P. and more than 70 units of 2000 I.H.P. and over. These figures alone are a testimony to the reliability and trustworthiness of our engines.

Yours faithfully,
Sulzer Brothers.

Winterthur, Switzerland.

AMERICAN SHIPS WITH ELECTRICAL AUXILIARIES

To the Editor of "Motorship."
Sir:—

On looking over one of the issues of "Motorship" I noticed an article by Mr. Smith: "First full-powered motorship equipped with electric auxiliaries." The "Benowa" was not an American ship, though she was an American product. She was built for the Commonwealth Government Line of Australia, and flew the Australian flag.

The "Alabama" was an American ship equipped with electric auxiliaries with practically the same installation as the "Benowa" and went into commission on September 1, 1918, nearly a year previous to the "Benowa." She was also, I believe, the first full-powered motorship flying the American flag to cross the Pacific.

I was a member of the crew of both vessels.

Yours very truly,
O. W. Benham,
Chief Eng. M. S. "Boobyalla,"
Care of Comyn & Mc Call,
San Francisco, Cal.

DIESEL OIL $4.00 PER BARREL

The several private companies handling Diesel fuel-oil at the Panama Canal, namely, the Panama Agencies Co., the Union Oil Co., and the West India Oil Co., have advanced the price to $4.00 per barrel, according to Panama Canal record of June 9th. As these companies are protecting the motorship lines which have fueling contracts, they suggest that owners of motorships requiring Diesel fuel-oil make arrangements in advance of the ship's arrival.

BRITISH VERSUS AMERICAN MOTORSHIP CONSTRUCTION

(From "Syren and Shipping" of London)

Some of the finest motor-ships afloat are British-built, British-engined, and British-owned, and there are many more to follow. Our Scandinavian friends have achieved great things in connection with the motor-ship, but, after all, their resources are not to be compared with our own, and it is only a matter of time before our shipbuilding and marine engineering industries will take that place in motor-ship construction that we hold in regard to the building of steamships.

America, despite the considerable progress she has made in connection with the marine internal combustion engine, is not in the running with Great Britain, and at the rate at which our shipbuilders and engineers are developing their output we fancy that it will be a long time before our cousins across "the Pond" can claim to be serious rivals.

It is a good many years ago now that two large motor-ships were built on the Clyde for the East Asiatic Company, of Copenhagen. Both are still running under the Company's house flag, and are fine types of ships for the class of trade in which they are engaged. But far finer ships have been produced in this country since these vessels were delivered, and even better ones are under construction.

OUR REGISTRY OF ENGINEERS

Among engineers of motor vessels who recently entered their names at this office was Mr. Charles E. Jackson, 401 West Twenty-third street, New York, and of 3541 Schubert Avenue, Chicago. Mr. Jackson has an unlimited motorship license for first assistant engineer, and an unlimited second-assistant engineers' license for steam. He has been on the motorship "Pinthus," "Texaco 146" and "Mount Baker," and for five years was operator of Busch-Sulzer stationary-type Diesel-engines.